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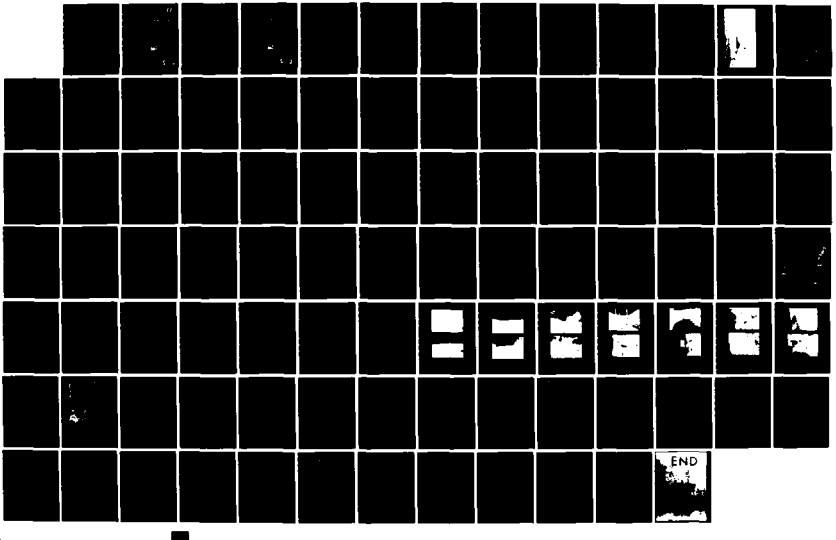

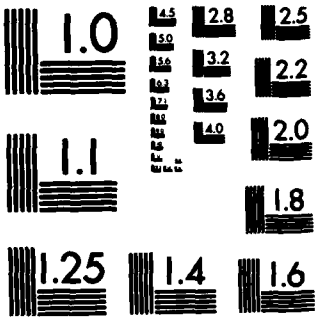

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HOUSATONIC RIVER BASIN

BETHANY, CONNECTICUT

NEW NAUGATUCK RESERVOIR DAM
CT 00307

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER, 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Housatonic River Basin
Bethany, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The New Naugatuck Reservoir Dam consists of an earth fill embankment with a concrete corewall, a spillway and spillway channel with an earthfill embankment dike. The dam is 790 ft. long including the spillway. Based upon the visual inspection at the site and past performance, the dam is judged to be in good condition. In accordance with the Corps of Engineers Guidelines for size (intermediate) and hazard (high) classification for the dam, the test flood is considered to be equivalent to the Probable Maximum Flood.

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HOUSATONIC RIVER BASIN

BETHANY, CONNECTICUT

NEW NAUGATUCK RESERVOIR DAM
CT 00307

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER, 1979

BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	NEW NAUGATUCK RESERVOIR DAM (LONG HILL RESERVOIR)
Inventory Number:	CT 00307
State Located:	CONNECTICUT
County Located:	NEW HAVEN
Town Located:	BETHANY
Stream:	BEACON HILL BROOK
Owner:	THE CONNECTICUT WATER COMPANY
Date of Inspection:	NOVEMBER 6, 1979
Inspection Team:	PETER M. HEYNEN, P.E. MIRON PETROVSKY JAY A. COSTELLO HECTOR MORENO, P.E.

The New Naugatuck Reservoir Dam, built in 1914, consists of an earth fill embankment with a concrete corewall, a spillway and spillway channel with an earth fill embankment dike. The dam is 790 feet long including the spillway. The top of the dam (elevation 540.8) is 20 feet wide and is 80± feet above the streambed of Beacon Hill Brook. The corewall has a top elevation of 537.8 or 3 feet below the top of the dam. The spillway, located at the left end of the dam, is 40.5 feet long at the crest and consists of a concrete ogee weir and a stone paved discharge channel. The dike is 310 feet long, 10 feet high and 10 feet wide at the top. The outlets are a 16 inch upper level outlet at the left side of the dam near the toe of the dike and a 12 inch low-level outlet at the downstream toe of the dam.

Based upon the visual inspection at the site and past performance, the dam is judged to be in good condition. No evidence of instability was observed in the dam or dike embankments. The condition of the spillway and outlet channels appear to be good. There are areas requiring attention and monitoring such as seepage along the downstream toe of the dam embankment.

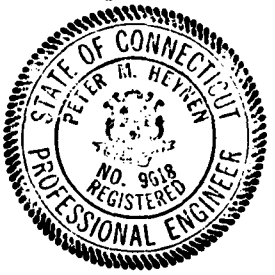
In accordance with the Corps of Engineers Guidelines for size (Intermediate) and hazard (High) classification for the dam, the test flood is considered to be equivalent to the Probable Maximum Flood (PMF). Peak inflow to the reservoir is 5,400 cubic feet per second (cfs); peak outflow is 4,150 cfs with the dam overtopped 0.8 feet. The spillway capacity with the reservoir level to the top of the dam is 2,130 cfs, which is 51% of the routed test flood outflow.

It is recommended that the owner retain the services of a registered engineer to perform a more detailed inspection of the dam. Items of importance are; evaluation of the condition of the outlet pipes, origin and significance of seepage and wet areas at the toe of the dam and installation of piezometers to monitor the phreatic surface in the dam. Recommendations should be made by the engineer and implemented by the owner.

The above recommendations and further remedial measures which are discussed in Section 7, should be instituted within one (1) year of the owner's receipt of this report.

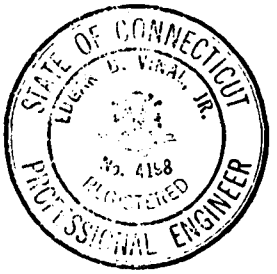
Peter M. Heynen

Peter M. Heynen, P.E.
Project Manager Geotechnical
Cahn Engineers, Inc.



Edgar B. Vinal, Jr.

Edgar B. Vinal, Jr., P.E.
Senior Vice President
Cahn Engineers, Inc.



This Phase I Inspection Report on New Naugatuck Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and are hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL C. COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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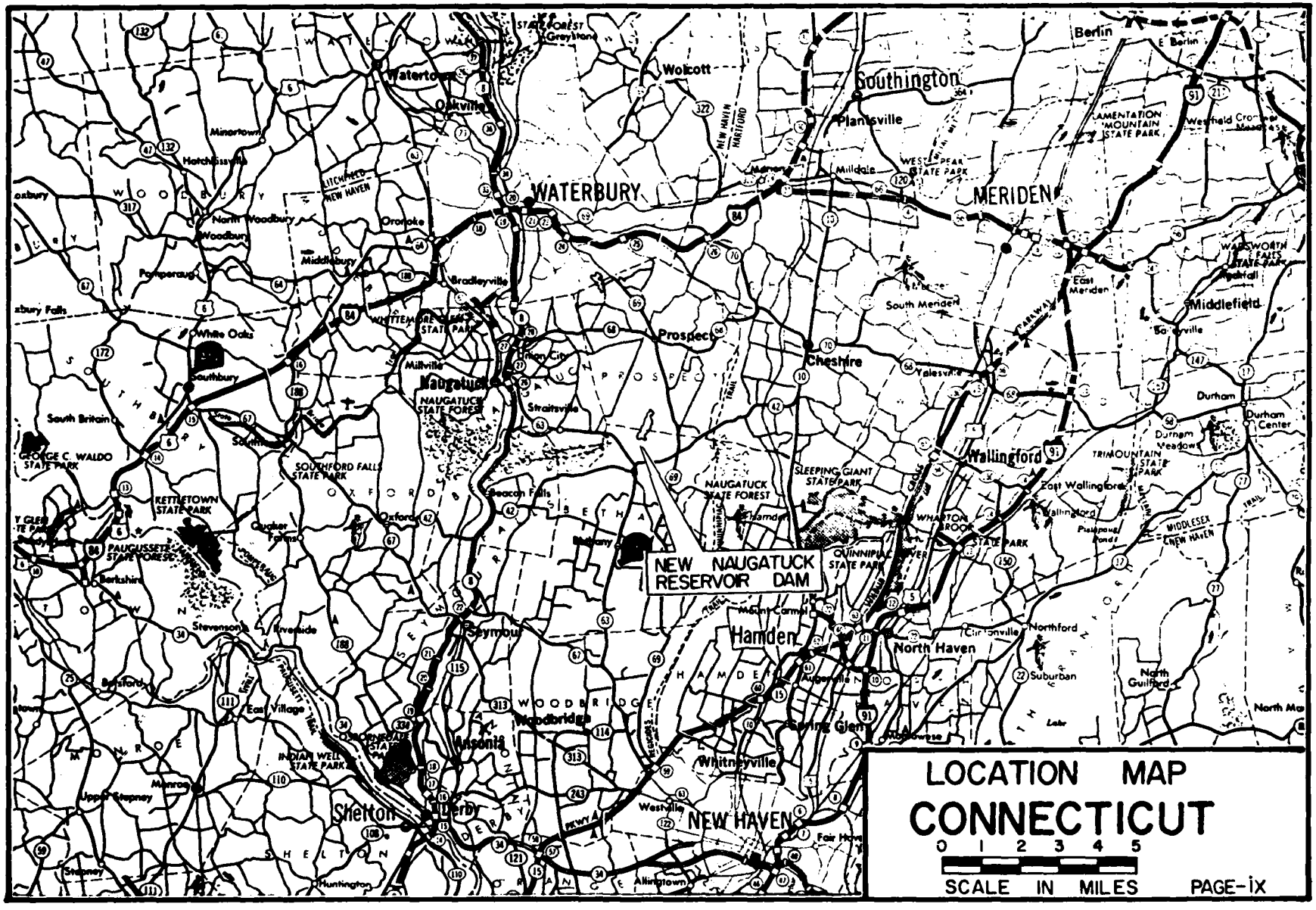
APPENDICES

OVERVIEW PHOTO
(November 1979)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	New Naugatuck Reservoir Dam	Bethany	DATE Dec '79
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED DAMS	Beacon Hill Brook	CONNECTICUT	CE #27 660 KE PAGE viii



LOCATION MAP

CONNECTICUT

0 1 2 3 4 5

SCALE IN MILES

PHASE I INSPECTION REPORT

NEW NAUGATUCK RESERVOIR DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of October 15, 1979 from William E. Hodgson, Jr. Colonel, Corps of Engineers. Contract No. DACW 33-79-C-0059 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dam.

3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

3. Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

4. An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features of the dam which need corrective action and/or further study.

1.2 DESCRIPTION OF PROJECT

a. Location - The dam is located on Beacon Hill Brook in a rural area of the town of Bethany, County of New Haven, State of Connecticut. The dam is shown on the Mount Carmel USGS Quadrangle Map having coordinates latitude N 41°27.9' and longitude W 72°58.1'.

b. Description of Dam and Appurtenances - The project consists of a 790± foot long earth fill embankment dam, a 40.5 foot long spillway at the left end of the dam and a spillway channel with a 310 foot long earth fill embankment dike.

The dam has a top elevation of 540.8, which is 80± feet above the streambed of Beacon Hill Brook and 6 feet above the spillway crest. The top of the dam is 20 feet wide and has a grass cover. The upstream slope is riprapped to within 2± feet of the crest and has an inclination of 2 horizontal to 1 vertical. The downstream slope has a grass cover, is inclined at 2 horizontal to 1 vertical and has a 5 foot wide berm at elevation 502±. A concrete corewall extends along the axis of the dam for the entire length of the embankment and has a top elevation of 537.8.

The dike is located at the left end of the dam and forms the spillway channel (See Sheet B-1). The dike is 310 feet long, 10 feet high and 10 feet wide at the top. The slope on the channel side is inclined at 1.5 horizontal to 1 vertical and has riprap placed to within 2 feet of the top of the dike. The back slope is grass covered and is also inclined at 1.5 horizontal to 1 vertical. The top of the dike is grass covered and ranges in elevation from 540± at the upstream end to 538± at the downstream end.

The spillway consists of a concrete ogee shaped weir and a spillway channel. The weir is 40.5 feet long, has a crest elevation of 534.8 and concrete training walls with a top elevation of 540.8. The spillway channel is 40± feet wide, 310 feet long and has stone paving along the channel floor.

The low-level outlet consists of 20 inch and 16 inch inlet valves, a 20 inch cast iron pipe which extends to a gate house at the downstream toe of the dam, and a series of outlet valves. The 20 inch inlet valve is at elevation 485.5 and the 16 inch inlet valve is at 504.8. These valves are controlled with operating handles from a chamber located at the central part of the top of the dam. At the downstream gate house there are four gate valves; a 20 inch valve, a 12 inch valve and reducer, a 12 inch automatically controlled valve, and a 12 inch manual valve at invert elevation 464± (See page B-12). The original 20 inch outlet pipe has been plugged and a new 12 inch pipe has been installed with the outlet to the left side of the gate house.

The upper level outlet consists of a 16 inch inlet valve at elevation 524.0 and a 16 inch automatically controlled outlet valve at invert elevation 520.3, which is housed in a concrete chamber at the toe of the dike about 100 feet from the spillway. The upper level inlet valve is controlled from a chamber located at the top left end of the dam. There is also an 8 inch outlet pipe (upstream invert elevation 530.8) located to the left of the right spillway training wall. The pipe is controlled with a hand operated valve stem located in the spillway approach channel 3 feet upstream from the spillway weir and 1 foot from the right training wall. The purpose of this pipe is unknown and it is presently not in use. There is also a mudgate which is located just below the 20 inch inlet valve.

There are two masonry channels; one from the upper level outlet and a second from the spillway channel (See Sheet B-1). These two channels meet approximately 200 feet downstream from the upper level outlet valve chamber to form the lower spillway channel which extends another 400± feet downstream to a small concrete dam and compensating pond. The channel from the upper level outlet is about two feet wide and the lower spillway channel is approximately 4 feet wide. Both channels have stone masonry sidewalls and a mortar lined floor.

c. Size Classification (INTERMEDIATE) - The dam impounds 2,140 acre-feet of water with the reservoir level at the top of the dam, which at elevation 540.8, is 80± feet above the streambed. According to the Recommended Guidelines, a dam with this height and storage capacity is classified as intermediate in size.

d. Hazard Classification - HIGH - If the dam were breached, there is potential for loss of life and extensive property damage to at least 4 houses which are situated 6 to 13 feet above the streambed and located along Beacon Hill Brook and Route 63 between 3000 and 7000 feet downstream.

e. Ownership - Connecticut Water Company
93 West Main Street
Clinton, Connecticut
Mr. Kenneth Kells (203) 669-8636

f. Operator - Mr. William T. Dunn
250 Meadow Street
Naugatuck, Connecticut (203) 729-8241

g. Purpose of Dam - Water Supply

h. Design and Construction History - The following information is believed to be accurate based on the plans and correspondence available. The dam was designed by George C. Ham and constructed by the Connecticut Water Company in 1914. The flashboards at the spillway weir were permanently removed in October 1969. The lower spillway channel, which was damaged by high water, ice and freezing in January, 1979, was reconstructed in the spring of the same year.

i. Normal Operational Procedures - When the level of Twitchell Reservoir (downstream) drops below acceptable levels, the water level is re-established by flows from the outlets at New Naugatuck Reservoir. The upper level outlet is opened first and when the head in New Naugatuck Reservoir drops 4± feet, the low-level outlet is used. (For more details see Section 4.1). The 16 inch inlet valve for the low-level outlet is normally open and the 20 inch valve is kept closed. The 16 inch inlet valve for the upper level outlet is also kept open and flow through this outlet is controlled from the concrete chamber at the downstream toe of the dike.

1.3 PERTINENT DATA

a. Drainage Area - 2.6 square miles of relatively undeveloped rolling wooded terrain.

b. Discharge at Damsite - Discharge is over the spillway, through the 8 inch pipe at the spillway and through the upper level or low-level outlets.

1. Outlet Works (conduits):	
8 inch outlet @ spillway weir:	Unknown
12 inch low-level outlet @ invert el. 464:	56 cfs @ 77 feet of head
16 inch upper level outlet @ invert el. 520.3:	25 cfs @ 21 feet of head
2. Maximum known flood @ damsite:	Unknown
3. Ungated spillway capacity @ top of dam el. 540.8:	2130 cfs
4. Ungated spillway capacity @ test flood el. 541.6:	2520 cfs
5. Gated spillway capacity @ normal pool el.:	N/A
6. Gated spillway capacity @ test flood el.:	N/A
7. Total spillway capacity @ test flood el. 541.6:	2520 cfs
8. Total project discharge @ test flood el. 541.6:	4150 cfs

c. Elevations (National Geodetic Vertical Datum)

1. Streambed @ toe of dam:	461±

2. Maximum tailwater:	Unknown
3. Upstream portal invert diversion tunnel:	N/A
4. Recreation pool:	N/A
5. Full flood control pool:	N/A
6. Spillway crest (ungated):	534.8
7. Design surcharge (original design):	Unknown
8. Top of dam:	540.8
9. Top of dike:	538.0 to 540.0
10. Test flood surcharge:	541.6

d. Reservoir

1. Length of maximum pool:	4500 ft.
2. Length of spillway crest pool:	4300 ft.
3. Length of flood control pool:	N/A

e. Storage

1. Recreation pool:	N/A
2. Flood control pool:	N/A
3. Spillway crest pool:	1550 acre-ft.
4. Top of dam pool:	2140 acre-ft.
5. Test flood pool:	2220 acre-ft.

f. Reservoir Surface

1. Recreation pool:	N/A
2. Flood control pool:	N/A
3. Spillway crest pool:	84 acres
4. Top of dam pool:	108 acres
5. Test flood pool:	110 acres

g. Dam

1. Type:	Earth embankment

2. Length:	790 ft.
3. Height:	80 ft.
4. Top width:	20 ft.
5. Side slopes:	2H to 1V Upstream 2H to 1V Downstream
6. Zoning:	Unknown
7. Impervious core:	Concrete corewall with puddled clay
8. Cutoff:	N/A
9. Grout curtain:	N/A
10. Other:	Earthfill dike along spillway channel. Dike is 310 feet long, 10 feet high and 10 feet wide at the top.

h. Diversion and Regulatory Tunnel - N/A

i. Spillway

1. Type:	Concrete ogee weir with paved spillway channel downstream
2. Length of weir:	40.5 ft. (at crest)
3. Crest elevation:	534.8
4. Gates:	N/A
5. Upstream channel:	Gravel and rock sloping at 12H to 1V.
6. Downstream channel:	Stone paved for 310 feet with a boulder section and then masonry channel

j. Regulating Outlets

Low-level outlet

1. Invert:	464± (downstream)

2.	Size:	12 inch
3.	Description:	Cast iron
4.	Control Mechanism:	Manual and automatically controlled valves downstream and manual valves at inlets controlled with operating handles from top of dam.
5.	Other:	20 inch pipe between inlets and outlet. Original outlet plugged and 12 inch added.

Upper level outlet

1.	Invert:	520.3 (downstream)
2.	Size:	16 inch
3.	Description:	Cast iron
4.	Control Mechanism:	Automatic and manual downstream and manual upstream controlled with operating handle from top of dam.
5.	Other:	N/A

8 inch outlet

1.	Invert:	380.0 (at spillway weir)
2.	Size:	8 inch
3.	Description:	Cast iron
4.	Control Mechanism:	Hand operated stem in spillway approach channel.
5.	Other:	N/A

Mud gate: No information

SECTION 2: ENGINEERING DATA

2.1 DESIGN

a. Available Data - The available data consists of plans, operations and maintenance manual and correspondence. The plans are design drawings from 1913 and as-built drawings dated 1914, both by George C. Ham, C.E. The correspondence consists of storage computations and lake level readings from the Connecticut Water Company, general specifications by George C. Ham and obtained from the Connecticut State Library, and inventory sheets from the Connecticut Department of Environmental Protection.

b. Design Features - The drawings and correspondence indicate the design features stated previously in this report.

c. Design Data - There were no engineering values, assumptions, tests results or calculations available for the original construction of the dam.

2.2 CONSTRUCTION

a. Available Data - The available construction data consists of the as-built drawings and general specifications as listed in 2.1.a.

b. Construction Considerations - No information was available for any problems or changes made during construction of the dam.

2.3 OPERATIONS

Reservoir level readings are taken once a week. According to the owner, the dam spillway capacity has never been exceeded or the dam overtopped. A short operations manual and water level readings prepared by the Connecticut Water Company are presented in Appendix B.

2.4 EVALUATION

a. Availability - Existing data was provided by the Connecticut Department of Environmental Protection, Connecticut State Library and The Connecticut Water Company. The owner made the project available for visual inspection.

b. Adequacy - The limited amount of detailed engineering data available was generally inadequate to perform an in-depth assessment of the dam, therefore the final assessment of this dam must be based primarily on visual inspection, performance history, hydraulic computations of spillway capacity and approximate hydrologic judgements.

c. Validity - A comparison of record data and visual observations reveals no observable significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the project is good. The inspection did reveal some areas requiring maintenance and monitoring. The reservoir level was 528.0± at the time of our inspection, i.e. 12± feet below the top of the dam.

b. Dam

Crest - The top of the dam shows no signs of misalignment, visible cracks or erosion (Photos 1 and 2).

Downstream Slope - There was no misalignment or sloughing noted on this slope (Photo 1). An extensive wet area was observed at the left end of the toe of the dam, just above the berm (Photos 12, 13, 14). Seepage from this area is flowing along the toe and down toward the gate house and low-level discharge channel. The stream flowing out from this area had a measured discharge approximately 30 gallons per minute (Photo 11).

Erosion was observed on the downstream slope and toe of the dam about 15 feet from the left side of the gate house. The ground in this area was wet and soggy.

Spillway - The concrete at the spillway weir and training walls is in good condition. No cracks or efflorescence was observed (Photos 3 through 5). The expansion joints of the training walls appear to be watertight.

The stone paved floor of the spillway channel is in good condition. Tall weeds growing on the channel floor were observed (Photos 4 and 5).

The left slope of the spillway channel is natural ground. There is riprap and a short dry-laid stone wall at the toe of this slope adjacent to the left spillway training wall. There is deterioration of this masonry wall, with some of the stones loose and falling into the spillway channel. The right slope of the spillway channel is the riprapped and grassed slope of the dike. This slope was in good condition (Photo 5). No erosion on the top or downstream slope of this dike was noted (Photo 6).

The lower spillway channel and the channel from the upper level outlet appear to be newly constructd with no cracks or deterioration observed in the channels.

c. Appurtenant Structures - The chambers (on the top of the dam) for operating the upper level and low-level inlet valves, the upper level outlet valve chamber and the low-level gate house are all in good condition (Photos 1, 2 and 10). No cracks or spalling of the concrete was observed. A 2 inch deep layer of water, probably from recent rainfall was noted on the floor of the operating chamber for the low-level intake valve. Water, caused by leaking valves, was also noted at the bottom of the concrete chamber at the low-level gatehouse.

The masonry walls and stone paved portion of the outlet channel at the low-level gatehouse are in good condition.

d. Reservoir Area - The area surrounding the reservoir is generally wooded and undeveloped.

e. Downstream Channel - The downstream channel runs in the natural streambed of the old Beacon Hill Brook. It is mostly undeveloped, steep-sided and wooded to the initial impact area.

3.2 EVALUATION

Based upon the visual inspection, the project is assessed as being generally in good condition. The following features which could influence the future condition and/or stability of the project were identifed.

1. Seepage through the left portion of the dam can potentially increase in flow, leading to erosion and sloughing of the downstream slope and instability of the dam.

2. Erosion on the downstream slope and toe to the left of the gate house could lead to structural problems in this area.

3. Pressure in the upper and lower outlet pipes, caused by leaving the upstream valves open and controlling the flow through these pipes with the downstream valves, could cause seepage into and through the embankment.

4. The damaged riprap and retaining wall at the left side of the spillway channel could result in erosion of this slope and the spillway training wall during high flows through the spillway channel.

5. Water on the floor of the low-level intake valve chamber could increase the deterioration process of the concrete in the chamber due to freeze-thaw cycles.

SECTION 4: OPERATIONAL PROCEDURES

4.1 REGULATING PROCEDURES

By operating a three-way switch in the lower gate house, control of the valves at the dam can be set for automatic upper level outlet, automatic low-level outlet or manual control at each outlet. The switch is usually set for automatic control at the upper outlet. When the water level in Twitchell Reservoir (1000 feet downstream) drops 14 inches, the upper level automatically controlled 16 inch outlet valve at the dam opens to refill Twitchell. When the water level at New Naugatuck Reservoir drops 4± feet, there is no longer enough head to operate this valve and it must be opened manually and flow controlled at the inlet valve. Automatic control is now switched to the lower outlet valve, which also augments Twitchell Reservoir. When Twitchell Reservoir reaches a sufficient level, the lower valve shuts down and the upper level valve is returned to automatic control, using the switch in the gate house. Of the two inlets for the low-level outlet, only the 20 inch (el. 504.8) valve is open.

4.2 MAINTENANCE OF DAM

The dam is patrolled daily and checked for debris and obstacles in the spillway and the stream leading to Twitchell Reservoir. Also, a check is made for unusual trespassing, floating debris and animal burrows. The grass is cut every month (weather permitting) and brush removed. Trees are not allowed to infringe upon the slopes of the embankments.

4.3 MAINTENANCE OF OPERATING FACILITIES

Valves and gates are flushed and cleaned once a year and all outlets checked.

4.4 DESCRIPTION OF ANY FORMAL WARNING SYSTEM IN EFFECT

Any problem situations arising at the dam are reported to the Connecticut Water Company Division Manager. Other than this, no formal warning system is in effect.

4.5 EVALUATION

The operation and maintenance procedures are generally good, however there are some items requiring improvement. A formal warning system should be developed and implemented within the time frame indicated in Section 7.1c. Recommended operation and maintenance improvements are presented in Section 7.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. General - The watershed is 2.6 square miles of relatively undeveloped rolling wooded terrain. The dam is an earth embankment which is a high surcharge storage - low spillage project. The dam develops sufficient storage to reduce the Probable Maximum Flood (PMF) from about 5,400 cfs to 4,150 cfs (about a 23% reduction) and the 1/2 PMF from about 2,700 cfs to 1,680 cfs (about a 38% reduction).

b. Design Data - No computations could be found for the original dam construction.

c. Experience Data - No information was found to indicate that there have been any serious problems with the dam, and it was reported that the dam has not been overtopped. The maximum height of water over the spillway since removal of the flashboards in October 1969 was reported as 20 inches on January 25, 1979. The maximum reservoir level before removal of the flashboards was recorded as 32.5 inches over the spillway crest in February 1964.

d. Visual Observations - The dam embankment is well maintained. A new masonry discharge channel has been recently constructed between the spillway channel and the compensating pond, 600 feet downstream.

e. Test Flood Analysis - Based upon the Army Corps of Engineers' "Preliminary Guidance for Estimating Maximum Probable Discharge", dated March 1978, the watershed area (2.6 square miles) and classification (rolling), a Probable Maximum Flood (PMF) of 5400 cfs, or 2100 cfs per square mile, is expected at the dam site. In accordance with the size (intermediate) and hazard (high) classification, the test flood is considered to be equivalent to the PMF.

Peak inflow to the reservoir at the PMF is 5,400 cfs and peak outflow is 4,150 cfs with the dam overtopped 0.8 feet (Appendix D-13). Based upon our hydraulic computations, the spillway capacity to top of dam is 2130 cfs which is approximately 51% of the routed test flood outflow. Peak inflow at the ½ PMF 2,700 cfs, peak outflow will be 1680 cfs with the water level in the reservoir to elevation 539.8.

f. Dam Failure Analysis - Utilizing the April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs", the peak failure outflow from the dam breaching would be 103,000 cfs. A breach of the dam would result in a rise of about 20 feet in the water level of the stream at the initial impact area, which corresponds to an increase in the water level from a depth of 6.5 feet just before the breach, to a depth of 26.2 feet just after the breach. The rapid 20± foot increase in the water level at the initial impact area would inundate at least four houses along Beacon Hill Brook to a depth of 13 to 20 feet. These houses are located 6 to 13 feet above the streambed between 3000 and 7000 feet downstream from the dam (See Sheet D-1). There are other structures further downstream which might be subject to flooding as the stream passes through a heavily populated area in the suburbs of Waterbury.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The visual inspection did not reveal any indications of immediate stability problems. There are areas of seepage, masonry deterioration and erosion as described in Section 3, however they are not considered stability concerns at the present time.

b. Design and Construction Data - There is not adeqiate design and construction data available to permit an in-depth assessment of the structural stability of the project or the appurtenant structures.

c. Operating Records - The available operating records do not reveal any indications of instability in the dam since its construction in 1914.

d. Post Construction Changes - The only indication of post-construction changes of the project is reconstruction of the lower spillway channel in 1979 and the installation of the 12 inch outlet at the low-level gatehouse.

e. Seismic Stability - The project is in Seismic Zone 1 and according to the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 PROJECT ASSESSMENT

a. Condition - Based upon the visual inspection and past performance, the project appears to be in good condition. No evidence of structural instability was observed. The dam embankment is in good condition, although there are areas which require maintenance and monitoring, such as seepage along the downstream toe of the dam and erosion to the left of the low-level gatehouse.

Based upon the Army Corps of Engineers' "Preliminary Guidance for Estimating Maximum Probable Discharge" dated March, 1978 and hydraulic/hydrologic computations, the peak inflow to the reservoir is 5,400 cfs and the peak outflow is 4,150 cfs with the dam overtopped 0.8 feet. Based upon our hydraulic computations, the spillway capacity is 2,130 cfs, which is equivalent to approximately 51% of the routed test flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the project must be based solely on visual inspection, past performance of the project, and sound engineering judgement.

c. Urgency - It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within one year of the owner's receipt of this report.

7.2 RECOMMENDATIONS

It is recommended that further studies be made by a registered professional engineer qualified in dam design and inspection pertaining to the following:

1. Flow through the 16 inch upper level and 20 inch low-level outlets should be regulated with the upstream valves. This will eliminate pressures in these pipes within the embankment and therefore, reduce the possibility of seepage into the embankment from these pipes.

2. Inspection of the project during a period of high head and make any necessary recommendations. Items of particular importance are as follows:

   (a) The origin and significance of the wet area and seepage at the toe of the dam. This should include installation of weirs and rain gauges, and monitoring of seepage flows at various reservoir elevations.

   (b) Installation of piezometers for determination and monitoring of the phreatic surface in the dam, and for evaluation of the permeability of the concrete corewall.

3. Evaluation of the condition of the 16 inch and 20 inch outlet pipes. This may be done by closing the upstream valve, opening the downstream valve and checking for seepage flow into the pipe from the embankment.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures - The following measures should be undertaken within the time period indicated in Section 7.1.c, and continued on a regular basis.

1. Round-the-clock surveilance should be provided by the owner during periods of unusually heavy precipitation and high project discharge. The owner should develop and implement a downstream warning system to be used in case of emergencies at the dam.

2. The present program of inspection should be continued and should include an annual inspection by a registered professional engineer qualified in dam inspection.

3. Seepage and wet areas at the left side of the toe of the dam should be monitored periodically (as recommended by the engineer) to measure any changes in the seepage flow.

4. Erosion on the downstream slope of the dam near the gate house should be filled with suitable material, compacted and slope protection placed.

5. The damaged stone wall of the spillway channel, adjacent to the left spillway training wall, should be repaired to prevent erosion in the future.

6. Drain pipes should be installed in the floor of the concrete valve chambers and the gate house to eliminate deterioration of the concrete from accumulated water.

7. The cutting of grass and brush on the crest and slopes of the dam, the spillway dike and the floor of the spillway channel should be continued as part of the routine maintenance procedure.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE: NOVEMBER 6, 1979

TIME: 12:30 - 3:30 P.M

WEATHER: CLOUDY, 55°F

W.S. ELEV. 525.0 U.S. - DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. PETER M. HEYNEN	PMH	Geotechnical
2. MIRON PETROVSKY	MP	Geotechnical
3. JAY COSTELLO	JC	Geotechnical
4. HECTOR MORENO	HM	Hydraulic/Hydrologic
5. Moshe Norman	MN	Survey
6. Kenneth Kells	K.K	Owner Representative

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	EARTH DAM EMBANKMENT	PMH, MP, JC, MN	
2.	SPILLWAY DIKE	PMH, MP, JC, MN	
3.	UPPER-LEVEL INTAKE VALVE CHAMBER	PMH, MP, JC	
4.	UPPER LEVEL OUTLET VALVE CHAMBER	PMH, MP, JC	
5.	LOW-LEVEL INTAKE VALVE CHAMBER	PMH, MP, JC	
6.	LOW-LEVEL GATEHOUSE	PMH, MP, JC, HM	
7.	UPPER LEVEL OUTLET	PMH, MP, JC, HM	
8.	LOW-LEVEL OUTLET	PMH, MP, JC, HM	
9.	CONCRETE SPILLWAY AND SPILLWAY CHANNEL	PMH, MP, JC, HM, MN	
10.			
11.			
12.			

PERIODIC INSPECTION CHECK LIST

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE NOV. 6, 1979

PROJECT FEATURE EARTH DAM EMBANKMENT BY PMH, MP, JC, MN

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	540.8
Current Pool Elevation	528.0
Maximum Impoundment to Date	UNKNOWN
Surface Cracks	NONE OBSERVED
Pavement Condition	GRASS COVER
Movement or Settlement of Crest	NONE OBSERVED
Lateral Movement	
Vertical Alignment	APPEARS GOOD
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	GOOD
Indications of Movement of Structural Items on Slopes	SOME BULGE AT D/S CENTRAL AREA OVER BERM
Trespassing on Slopes	NONE OBSERVED
Sloughing or Erosion of Slopes or Abutments	SOME DEPRESSION AT D/S CENTRAL AREA OVER BERM; EROSION AT D/S SLOPE NEAR TOE
Rock Slope Protection-Riprap Failures	RIPRAP, GOOD
Unusual Movement or Cracking at or Near Toes	NONE OBSERVED
Unusual Embankment or Downstream Seepage	HEAVY SEEPAGE AT LEFT SIDE OF TOE WITH FLOW = NO LESS 30 GAL./MIN.
Piping or Boils	NONE OBSERVED
Foundation Drainage Features	N/A
Toe Drains	
Instrumentation System	

PERIODIC INSPECTION CHECK LIST

PROJECT New Naugatuck Reservoir Dam DATE Nov. 6, 1979

PROJECT FEATURE Spillway Channel Dike BY PMH, MP, JC, MN

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	540.0±
Current Pool Elevation	Dry spillway CHANNEL
Maximum Impoundment to Date	UnKNOWN
Surface Cracks	NONE OBSERVED
Pavement Condition	GRASS COVER
Movement or Settlement of Crest	NONE OBSERVED
Lateral Movement	
Vertical Alignment	APPEARS GOOD
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	NONE OBSERVED
Sloughing or Erosion of Slopes or Abutments	SOME TREES at d/s TOE
Rock Slope Protection-Riprap Failures	
Unusual Movement or Cracking at or Near Toes	NONE OBSERVED
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	N/A
Instrumentation System	
Trespassing on Slopes	NONE OBSERVED

PERIODIC INSPECTION CHECK LIST

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE Nov. 6, 1979

PROJECT FEATURE UPPER LEVEL INTAKE VALVE CHAMBER BY PM/MP, JC

AREA EVALUATED	CONDITION
OUTLET WORKS-CONTROL TOWER	
a) Concrete and Structural	
General Condition	GOOD
Condition of Joints	N/A
Spalling	NONE OBSERVED
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	N/A
Unusual Seepage or Leaks in Gate Chamber	NONE OBSERVED
Cracks	
Rusting or Corrosion of Steel	
b) Mechanical and Electrical	
Air Vents	N/A
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	OPERATING HANDLE OF 16" GATE VALVE, 16" VALVE IS OPERABLE
Emergency Gates	N/A
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE NOV. 6, 1979

PROJECT FEATURE UPPER LEVEL OUTLET VALVE CHAMBER BY PMH, MP, JC

AREA EVALUATED	CONDITION
OUTLET WORKS-CONTROL TOWER	
a) Concrete and Structural	
General Condition	GOOD
Condition of Joints	N/A
Spalling	NONE OBSERVED
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	N/A
Unusual Seepage or Leaks in Gate Chamber	NONE OBSERVED
Cracks	
Rusting or Corrosion of Steel	
b) Mechanical and Electrical	
Air Vents	N/A
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	16" AUTOMATIC ROSS VALVE, OPERABLE
Emergency Gates	N/A
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE Nov. 6, 1979

PROJECT FEATURE LOW-LEVEL INTAKE VALVE CHAMBER BY PMH/MP, JC

AREA EVALUATED	CONDITION
OUTLET WORKS-CONTROL TOWER	
a) Concrete and Structural	
General Condition	GOOD
Condition of Joints	N/A
Spalling	NONE OBSERVED
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	2" deep WATER ON FLOOR
Cracks	NONE OBSERVED
Rusting or Corrosion of Steel	
b) Mechanical and Electrical	
Air Vents	N/A
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	OPERATING HANDLES FOR 16" & 20" Ludlow GATE VALVES, 16" & 20" VALVES ARE OPERABLE
Emergency Gates	N/A
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT *New Naugatuck Reservoir Dam* DATE *Nov. 6, 1979*

PROJECT FEATURE *Low-Level Gatehouse* BY *PMH, MP, JC, HM*

AREA EVALUATED	CONDITION
OUTLET WORKS-CONTROL TOWER	
a) Concrete and Structural	
General Condition	Good
Condition of Joints	N/A
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	NONE OBSERVED
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	SOME LEAKS FROM GATE VALVES
Cracks	NONE OBSERVED
Rusting or Corrosion of Steel	
b) Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	N/A
Elevator	
Hydraulic System	
Service Gates	20" GATE VALVE, 12" ROSS AUTOMATIC VALVE & 12" GATE VALVE, OPERABLE
Emergency Gates	
Lightning Protection System	N/A
Emergency Power System	
Wiring and Lighting System	Good

PERIODIC INSPECTION CHECK LIST

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE Nov. 6, 1979

PROJECT FEATURE UPPER LEVEL OUTLET BY PMH, MP, JC, HM

AREA EVALUATED	CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	GOOD
Rust or Staining	NONE OBSERVED
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	N/A
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	NONE OBSERVED
Condition of Discharge Channel	GOOD

PERIODIC INSPECTION CHECK LIST

PROJECT NEW NAUGATUCK RESERVOIR DAM DATE NOV. 6, 1979

PROJECT FEATURE LOW-LEVEL OUTLET BY PMH, MP, JC, HM

AREA EVALUATED		CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL		MORTAR STONE WING WALLS
General Condition of Concrete		GOOD
Rust or Staining		N/A
Spalling		SOME DAMAGE OF LEFT WALL
Erosion or Cavitation		NONE OBSERVED
Visible Reinforcing		N/A
Any Seepage or Efflorescence		NONE OBSERVED
Condition at Joints		
Drain Holes		N/A
Channel		
Loose Rock or Trees Overhanging Channel		NONE OBSERVED
Condition of Discharge Channel		GOOD

PERIODIC INSPECTION CHECK LIST

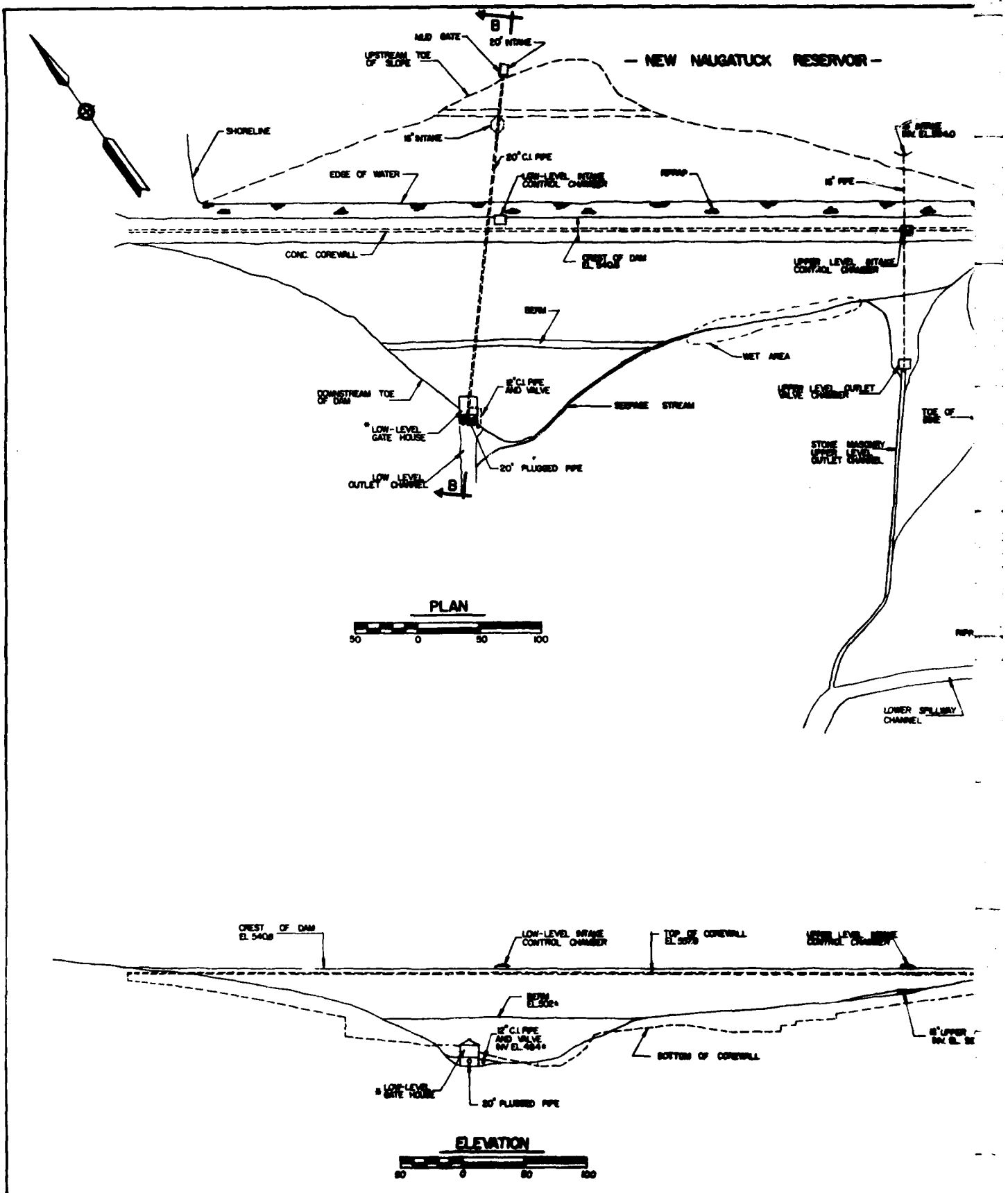
PROJECT NEW NAUGATUCK RESERVOIR DAM DATE NOV. 6, 1979

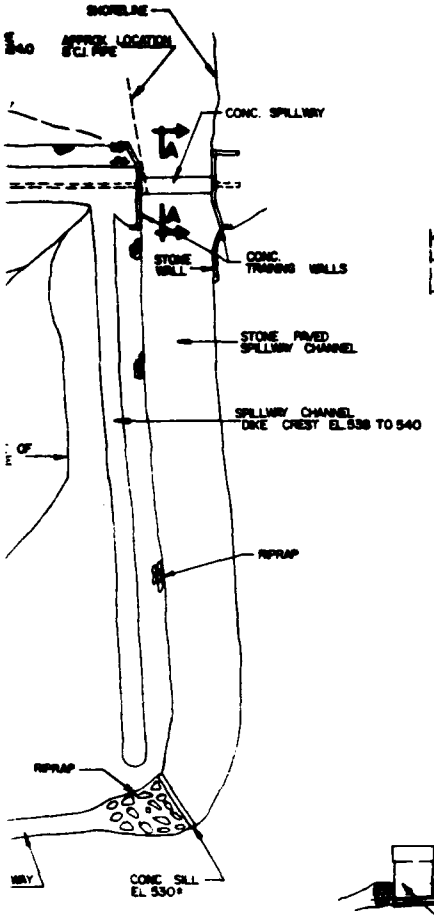
PROJECT FEATURE CONCRETE SPILLWAY AND SPILLWAY CHANNEL BY PMH, MP, JC, HM, MN

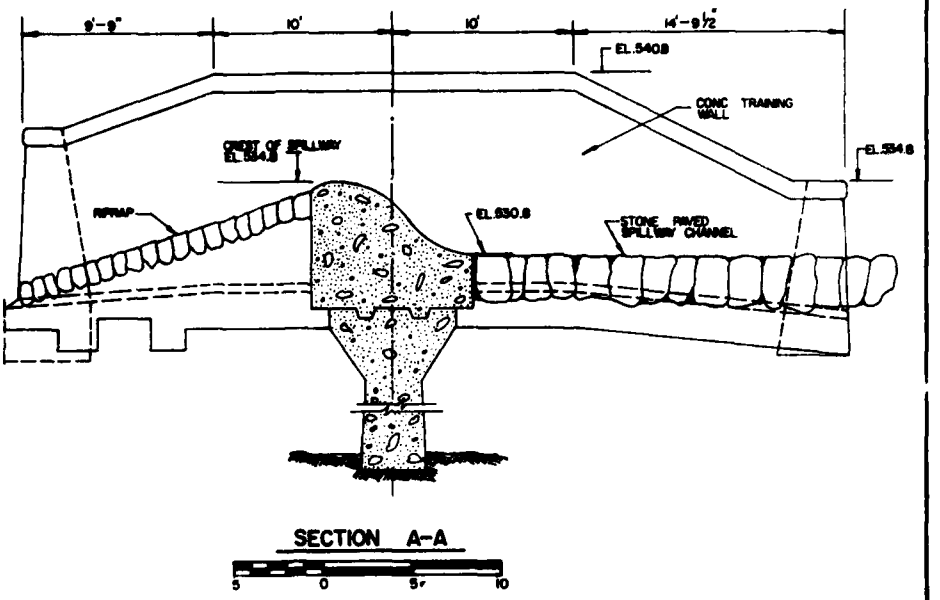
AREA EVALUATED	CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a) Approach Channel	
General Condition	GOOD
Loose Rock Overhanging Channel	NONE OBSERVED
Trees Overhanging Channel	
Floor of Approach Channel	GRAVEL AND STONE
b) Weir and Training Walls	
General Condition of Concrete	GOOD
Rust or Staining	NONE OBSERVED
Spalling	
Any Visible Reinforcing	
Any Seepage of Efflorescence	
Drain Holes	N/A
c) Discharge Channel	
General Condition	GOOD
Loose Rock Overhanging Channel	NONE OBSERVED
Trees Overhanging Channel	
Floor of Channel	STONE PAVING
Other Obstructions	GRASS & WEED

APPENDIX B

ENGINEERING DATA AND CORRESPONDENCE

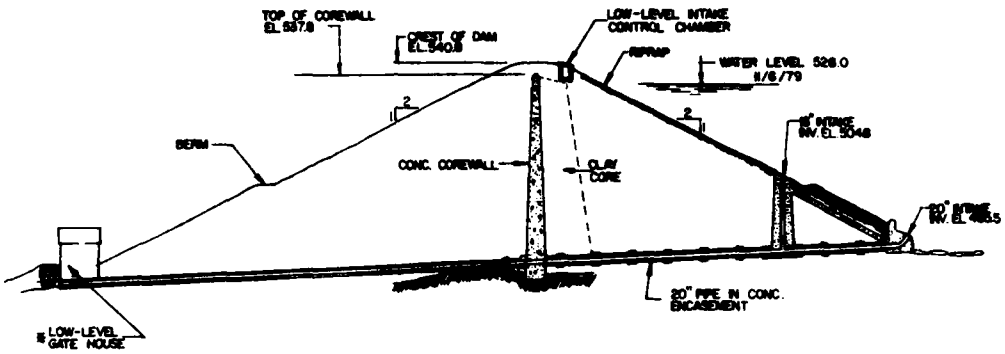

— NEW NAUGATUCK RESERVOIR —
B
MUD GATE
20" INTAKE
UPSTREAM TOE OF SLOPE
SHORELINE
18" INTAKE
20" CI. PIPE
EDGE OF WATER
LOW-LEVEL INTAKE CONTROL CHAMBER
RIPRAP
18" PIPE
CONC. COREWALL
CREST OF DAM EL. 540.8
UPPER LEVEL INTAKE CONTROL CHAMBER
BERM
WET AREA
DOWNSTREAM TOE OF DAM
12" CI. PIPE AND VALVE
SEEPAGE STREAM
UPPER LEVEL OUTLET VALVE CHAMBER
TOE OF DIKE
* LOW-LEVEL GATE HOUSE
20" PLUGGED PIPE
STONE MASONRY UPPER LEVEL OUTLET CHANNEL
LOW LEVEL OUTLET CHANNEL
B
RIPR
LOWER SPILLWAY CHANNEL
PLAN
50 0 50 100
CREST OF DAM EL. 540.8
LOW-LEVEL INTAKE CONTROL CHAMBER
TOP OF COREWALL EL. 537.5
UPPER LEVEL INTAKE CONTROL CHAMBER
BERM EL. 502±
12" CI. PIPE AND VALVE INV EL. 484±
BOTTOM OF COREWALL
16" UPPER INV EL. 52
* LOW-LEVEL GATE HOUSE
20" PLUGGED PIPE
ELEVATION
50 0 50 100





SECTION A-A

5 0 5 10



SECTION B-B

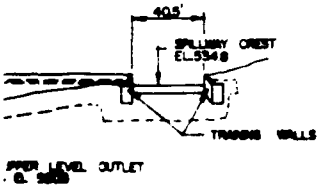
30 0 30 60

NOTES

1 THIS PLAN WAS COMPILED FROM PLANS BY GEORGE C. HAM, DATED 1913 AND 1914, AND FROM A SUPPLEMENTARY SURVEY BY CAHN ENGINEERS, INC NOVEMBER, 1979
NOT ALL STRUCTURAL AND/OR TOPOGRAPHICAL FEATURES ARE NECESSARILY IDENTIFIED.

2 ALL ELEVATIONS ARE NGVD ELEVATIONS.
NGVD = NEW NAUGATUCK DATUM + 150.8

3 SEE PAGE 8-12 FOR ARRANGEMENT OF VALVES.



RIVER LEVEL OUTLET EL. 528.0

CAHN ENGINEERS INC. WALLINGFORD, CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PLAN, ELEVATION AND SECTIONS

NEW NAUGATUCK RESERVOIR DAM

BEACON BROOK BETHANY, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE AS NOTED	
H.N.	JPC		DATE DEC. 1979	SHEET 8-1

2

EXISTING PLANS

"Plans Showing Long Hill Dam"
1913 and 1914
George C. Ham, C.E.
6 sheets

SUMMARY OF DATA AND CORRESPONDENCE

DUPLICATE.

LONG HILL BROOK DAM.

GENERAL SPECIFICATIONS.

PHILO-SELBY COMPANY, 172 CHAMBERS STREET NEW YORK

Br3

Naugatuck Water Co.

G E N E R A L S P E C I F I C A T I O N S.

Dam to be located about 200 feet below the function of Long Hill and Lacy brooks, in Town of Bethany. Spillway elevation 384 city datum. Top of dam 6 feet above water. Maximum depth of water 50 feet. Top length of dam to spillway 730 feet. Width of spillway 40 feet.

EXCAVATION.

All stumps, roots, soil or perishable material to be removed from site. Center trench to be dug to rock or into hard pan to a depth equal to 2/3 the depth of water over the surface.

Additional puddle trench near inner toe as shown.

Rock exposed in center trench to be cleaned and all seams grouted. Rock under core wall to be channeled from 1/2 to 2 feet or to a sound surface.

FILL.

Only sound materials to be used in the fill. Hard pan or sand, gravel and clay properly mixed shall be spread in 6 inch courses, sprinkled and rolled with a ten ton grooved roller. Selected material to be used on the up stream side of the core wall.

Sections which cannot be rolled will be puddled by sprinkling the earth into one foot of standing water.

No stones larger than 4 inches diameter to be used except near the toe.

CORE WALL & SPILLWAY.

Core wall to be concrete 3 feet wide, 2 feet above water with a 1/2 inch per foot batter on each side. A 6 inch by 12 inch tongue to rise to 3 feet above the water line.

Concrete to be mixed 1 part cement (Portland), 2 1/2 to

to 3 parts sand and 5 to 6 parts broken stone or gravel or as the sand and gravel or stone voids require.

In the wider parts of the wall and in the spillway 25% of clean plum stones up to 1 cubic feet may be used. Stones to be wet and placed at least 6 inches apart.

All joints vertical and horizontal shall be keyed and bonded with steel rods.

WASTE PIPES &c.

One line of 20 inch cast iron pipe with a 18 inch branch will be laid in a trench under the dam, also one line of 13 inch for a service pipe about 12 feet below the water level.

All pipe lines to be bedded and encased with at least 6 inches of concrete with cut off walls at joints as shown on plans.

Valves to be operated by rods laid in pipes up the slopes, or on brackets.

Inner slope to be paved, outer slope soiled or sodded as shown on plan.

The dam will be built in conformity with these specifications and the accompanying plans and in detail as directed by the engineer, George C. Ham, under whose supervision and to whose approval all the work shall be done.

No. R-1

WATER RESOURCES COMMISSION
SUPERVISION OF DAMS
INVENTORY DATA

3 CT-307

Long 72-58.1

Lat 41-27.9

Inventoried By I.C

Date

Name of Dam or Pond New Naugatuck Reservoir

Code No. N13.0 R.H. 39 H0.6

Nearest Street Location Litchfield Turnpike

Town Bethany

U.S.G.S. Quad. Mt. Carmel

Name of Stream Beacon Hill Brk.

Owner Conn. Water Co. - Naugatuck Div

Address West Main St
Clinton

NL 1/73

Pond Used For Public Supply D.A. 2.65M

Dimensions of Pond: Width _____ Length _____ Area 125. A

Total Length of Dam 750' Length of Spillway 91'

Location of Spillway East end

Height of Pond Above Stream Bed 20'

Height of Embankment Above Spillway 6'

Type of Spillway Construction Concrete

Type of Dike Construction

Downstream Conditions

1914

Summary of File Data application received 5/13/41 to install flashboards - completed 6/19/49

Remarks

(2 Hill)

Would Failure Cause Damage? YES Class B

VISUAL INSPECTION CHECKLIST FOR DAMS

The Connecticut Water Company

Dam Name: LONG HILL Inspection Date: 7/17/78

Present at Inspection: V. ROBERTS, E. RAHN, K. KELLS

Reservoir Level: DOWN 1'

General condition of slopes or dam faces: GOOD - EXCELLANT

Any evidence of erosion on upstream face? NO

On downstream face? NO

Any unwanted tree growth? YES - EAST OF VALVE (LOWER) HOUSE

Any animal burrows in slopes? NO

Any notable earth movements? NO

Any spongy spots or noticeable seepage? YES ALONG EAST TOE - SWAMPY GROWTH

Spillway condition: EXCELLANT

Spillway Obstructions: NONE

Tail Race Conditions: GOOD

Downstream obstructions or undermining of spillway or splash pad: NONE

Comments or recommendations:

CUT 4 TREES EAST OF LOWER VALVE HOUSE FOR CHRISTMAS TREES

Prepared by: K.W. Kells date 7/17/78

Reviewed by: date

Distribution: KWK

OPERATIONS & MAINTENANCE MANUAL
LONG HILL RESERVOIR

Long Hill Reservoir is a public water distribution reservoir for the Naugatuck Division of The Connecticut Water Company. The dam is located at the south end of the reservoir in the town of Bethany and its access is from Route 63. The reservoir impounds water in the town of Bethany and Prospect. See attached map. Long Hill Reservoir has a surface area of 82.5 acres and a watershed of approximately 2.47 square miles. At the spillway crest (535 feet U.S.G.S.) the storage capacity of the reservoir is 506 million gallons. The estimated safe yield of Long Hill is 1.88 MGD. This distribution reservoir supplies water to Twitchell Reservoir, a small compensating reservoir, which operates on the system gradient.

The dam at Long Hill Reservoir is a straight earth embankment with a concrete core wall. The dam is approximately 793 feet long with a maximum height of 71 feet. The grassed crest averages 20.0 feet in width. The upstream face is gradually sloping with rip rap protection from the base to the crest. The spillway is a 40'-10½" long broadcrested overflow weir situated at the extreme east end of the dam. The spillway has a freeboard of 72". Two pressure equalizers are bolted to either end of the spillway. These pipes protect the toe of the slope by preventing a vacuum from forming when water is spilling.

Besides the spillway, the water flow is controlled by two electrically operated Ross valves, model 50 FWR. A 16" Ross valve, the upper automatic, is housed approximately 100 feet from the spillway in a concrete vault. The lower automatic is a 12" Ross valve located at the toe of the dam approximately 525 feet from the spillway. When the level of Twitchell drops approximately 14 inches, this level can be adjusted as required, the upper automatic opens to refill Twitchell. It usually takes about 10 minutes for this flow of water to have an effect on Twitchell. When the water level drops about four feet in Long Hill, there no longer is enough head to operate the upper automatic. Operations call for the 16" Ross valve to be manually opened and the flow to Twitchell to be adjusted using the 16" Ludlow gate valve in the reservoir. With the upper automatic in the manual position, power is switched over to the lower automatic, and that too augments Twitchell. The purpose of both feeding Twitchell at the same time is to improve quality. When the water level drops below the invert

of the upper automatic (524 feet), Twitchell is then fed by the lower automatic. The lower automatic has two inverts, a 16" Ludlow gate valve at elevation 504.75 which is opened, and a 20" Ludlow gate valve at elevation 485.43 which is closed. See plan #1. Besides these invert gate valves, two others exist. An 8" gate exists at the northwest corner of the spillway at elevation 531. See plan #2. Also a mud gate, size and invert unknown, exists below the 20" Ludlow gate valve. Very little is presently known about the operation capability of either of these valves. The one near the spillway is visible when the reservoir is not spilling.

Present operations at the dam require whichever altitude valve is in service to open in case of power failure. When Twitchell is being filled by the upper automatic the lower automatic is opened and a 12" tapping valve in the wooden shed is cracked open to allow for some flushing of the line. The average summer drawdown is about five feet. During the drought of the mid 60's, the level of the reservoir was down 23½ feet. Flood flows have been read as high as 536.83 feet (20") over the spillway. This occurred on January 25, 1979.

The entrance to Long Hill Reservoir is fenced and the access gate is locked at all times. The reservoir is patrolled daily at various hours. The patrol of the area includes:

a.) A check of the spillway for debris and obstacles

b.) A check of the stream feeding Twitchell

c.) Any unusual activities, e.g. motorcycles, horseback riders, dead animals, animal burrows, etc.

Trespassing is not allowed on Water Company lands. All problems and violations are reported to the Division Manager as soon as possible. In addition to the patrolman, the pump station attendant inspects and maintains the aeration equipment at the reservoir.

Inspections of the embankments and foundations are at regular intervals using form CWC E-19. A copy of a typical inspection report is attached. Tree growth along the artificial fill area is closely monitored and is not allowed to encroach upon the fill area. Seasonal maintenance is done as required. Because chemical spills along Route 69 can be a problem, contingency plans have been drawn up in cooperation with local fire and police departments. Water Company lands near the reservoir are managed by Connwood of Rockfall, CT.

Copies of this manual are distributed to the Division Manager and Engineering Department.

10/26/79

Additional References:

1.) Reservoir and Dam Inspection Reports, Long Hill Reservoir
2.) Surface Water Book
3.) Flood levels
4.) Original maps of LHR are at Naugatuck offices, metal tube labeled "Long Hill Dam Tracings".

VFS/be
10/25/79

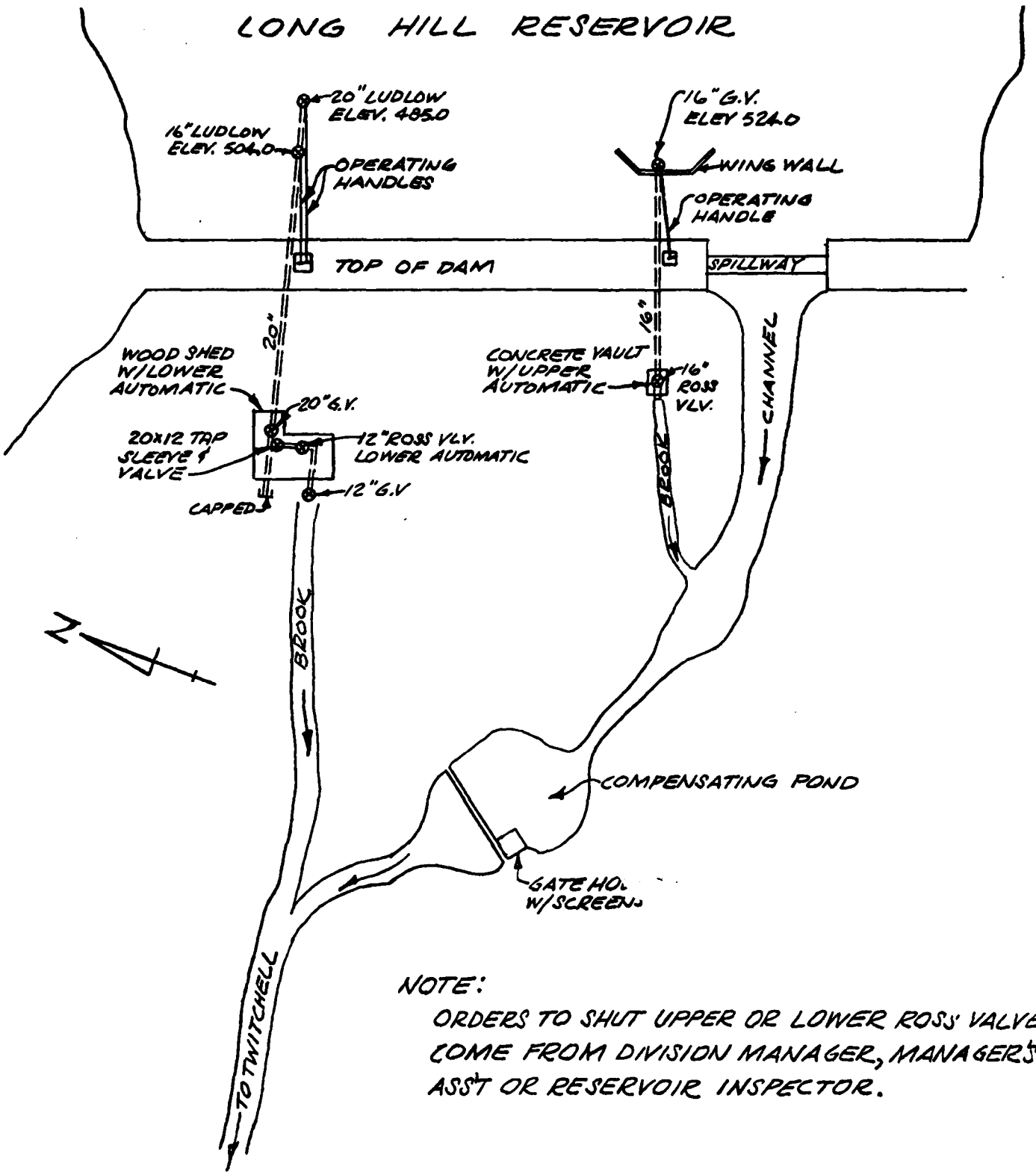
LONG HILL RESERVOIR

Contingency Plan for Chemical Spills

Oil or chemical spills on Route 69 affecting the reservoirs on the Marks Brook watershed would require immediate action. The reservoirs that would be affected are Long Hill Reservoir and Twitchell.

The number one priority of a chemical spill in this area is to keep the contamination out of Twitchell Reservoir. This priority is accomplished by closing the gate valves to contain the spill to a minimum number of reservoirs. See sketch. Generally, this procedure would be the responsibility of the Reservoir Inspector. He must react as quickly as possible to keep time to a minimum in isolating the source of contamination from the water supply. After containing the pollution, he shall notify his supervisor and begin cleanup operations immediately.

VFS/be
10/25/79

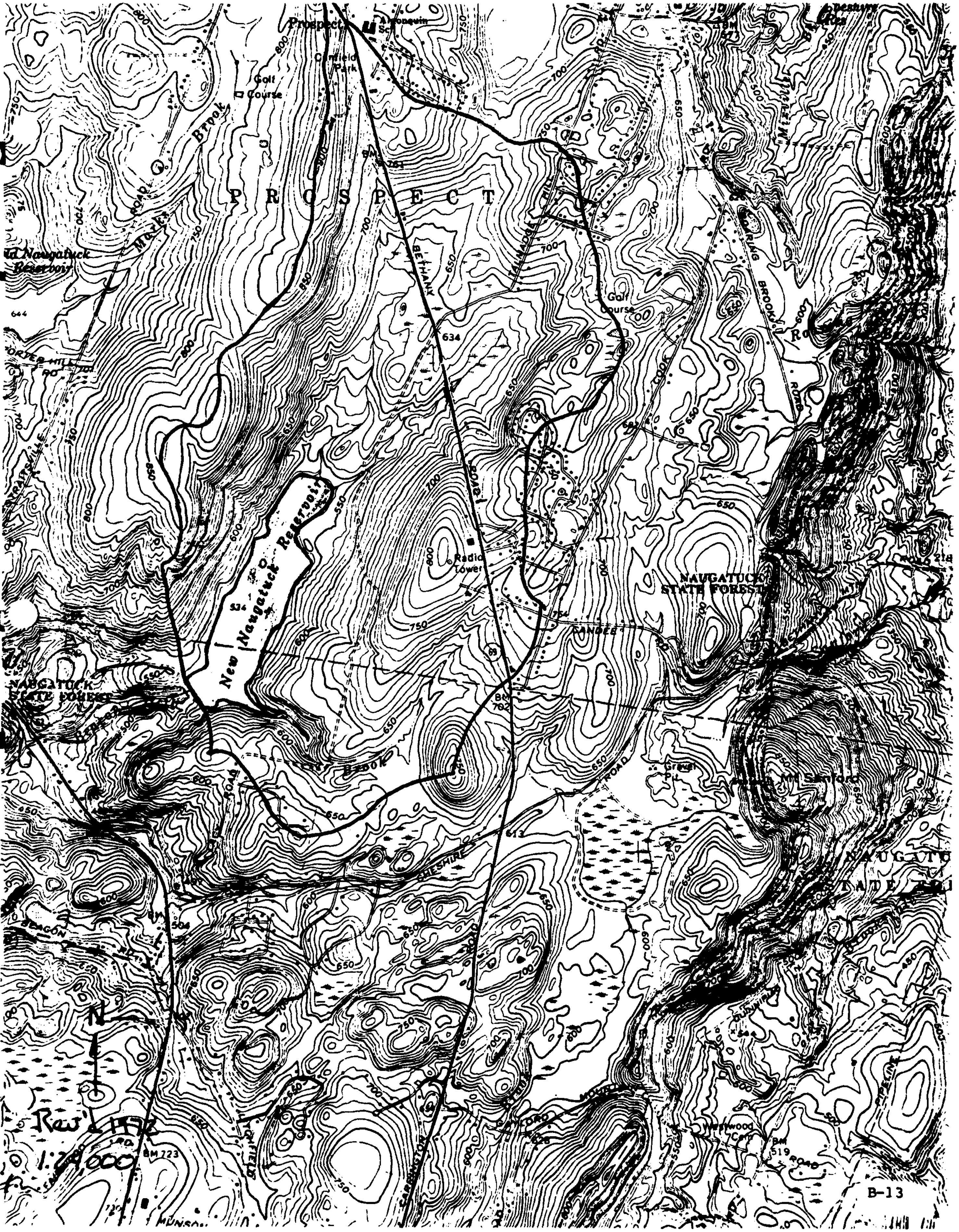


NOTE:

ORDERS TO SHUT UPPER OR LOWER ROSS' VALVE COME FROM DIVISION MANAGER, MANAGER'S ASS'T OR RESERVOIR INSPECTOR.

VALVE LOCATIONS AT LONG HILL RESERVOIR

NO SCALE 10/25/79B-12


Prospect
Golf Course
Brook
P R O S P E C T
Naugatuck Reservoir
BETHANY
Golf Course
634
New Naugatuck Reservoir
Radio Tower
NAUGATUCK STATE FOREST
CANDEE
NAUGATUCK STATE FOREST
Brook
Gravel Pit
Mt Sanford
CHESHIRE
N A U G A T U
S T A T E
N
Rev'd 1972
1:24000
BM 723
Westwood Cem
ROAD

B-13

Long Hill Keservoir

Top of Ch. shboards	M.G.
3	576
2	572
2'0"	567
10	562
8	557
6	552
4	547
2	542
1'0"	537
10	532
8	527
6	522
4	517
2	512
0'0"	506 Spillway
2	502
4	498
6	493
8	489
10	484
1'0"	480
2	476
4	472
6	468
8	464
10	460
2'0"	457
2	453
4	449
6	445
8	441
10	438
3'0"	435
2	431
4	428
6	425
8	422
10	419

	M.G.
4'0"	416
2	412
4	408
6	405
8	402
10	399
5'0"	396
2	393
4	390
6	387
8	383
10	380
6'0"	377
2	373
4	370
6	367
8	364
10	361
7'0"	358
2	355
4	352
6	349
8	346
10	343
8'0"	340
2	337
4	334
6	331
8	328
10	325
9'0"	322
2	319
4	316
6	313
8	310
10	307
10'0"	305
2	302

	M.G.
4	299
6	296
8	293
10	290
11'0"	287
2	284
4	281
6	279
8	277
10	275
12'0"	273
2	270
4	268
6	265
8	263
10	260
13'0"	258
2	255
4	253
6	250
8	248
10	245
14'0"	243
2	240
4	238
6	235
8	233
10	230
15'0"	228
3	224
6	220
9	216
16'0"	213
3	209
6	205
9	201
17'0"	198
3	194

	M.G.
6	191
9	188
18'0"	185
4	180
8	176
19'0"	171
4	167
8	162
20'0"	158

NOTE:

Tabulated figu. are gross volumes i storage. When figuring available supply subtract 70 M.G.

10/25/79

Cahn Engineers Inc.

April 10, 1980

CE #27 660 KD

Re: New Naugatuck Reservoir Dam

The following are excerpts pertaining to the New Naugatuck Reservoir Dam taken from correspondence obtained from the files of the Connecticut Water Company.

1. To: Files
   From: K.W. Kells
   Date: Oct. 21, 1976

   "Below are notes from my inspections of our dams with John Roberts of the Hartford Insurance Group."

   I. Long Hill with W. Dunn and W. Hill Oct. 14, 1976

      a). Seep exists on east side of dam in area where east inlet pipe is located. Had existed for some time.
      b). Next clearing of trees along the spillway outlet canal should include one more row of trees and one tree at south end west side of canal. Failure of canal wall during high runoff could cause erosion on downstream slope of dam.

2. To: William F. Guillaume, Connecticut Water Company
   From: John A. Roberts, Hartford Insurance Company
   Date: February 13, 1978

   Dear Mr. Guillaume:

   This letter will confirm Ken Kells and my visits to the dams during the month of January, 1978, and to thank Ken for his time and the courtesies extended to me.

   During these visits, we were accompanied by the Connecticut Water employees who have been selected and will be conducting the monthly inspections (other than the semi-annual months in which Ken conducts the inspections).

Cahn Engineers Inc.

In regards to those other Connecticut Water employees, I would like to mention at this time that I felt Ken provided sufficient guidance and training in what we were trying to accomplish during the inspections, use of the checklist that he developed, explanation of the terms on the checklist, and in general, how to carry out the visual inspections.

You more than likely already have the results of this survey from Ken and more than likely his report is more in depth and contains items that this letter does not, but I hope that there are no flagrant disagreements in our observations. This was the first time that we conducted the survey during the winter and it did allow us to make some observations without plant growth, but in other cases, we were not able to observe some areas that we wanted, due to snow and/or ice cover;

LONG HILL RESERVOIR

Seep in the toe of the slope on the east side could not be observed due to snow covering.

Ken felt that additional trees should be removed and directed Mr. Hill and Mr. Rahn to cut them this spring.

CAHN ENGINEERS, INC.

Jay A. Costello
Project Engineer

JAC:cap

LEVELS OF LONGHILL RES...

JANUARY 1	8	15	22	FEBRUARY 1	8	15	22	MARCH 1	8	15	22	APRIL 1	8	15	22	MAY 1	8	15	22	JUNE 1	8	15	22	JULY 1	8
5.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.4	1.2	1.2	1.7	0.8	0.7	0.5	0.3	-0.4
-13.0	-13.2	-12.6	-11.9	-11.7	-11.5	-10.6	-9.8	-9.8	-9.0	-8.0	-7.0	-3.8	-2.8	-2.7	-0.8	-0.0	0.8	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
-3.3	-3.9	-4.3	-3.8	-4.0	-3.8	-2.8	-2.1	-1.8	-0.7	-0.16	-1.2	-1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.0	0.0	0.0	-0.1
-8.0	-7.5	-7.7	-6.0	-5.2	-5.0	-4.2	-3.8	-3.5	-3.0	-2.0	-1.0	-0.5	-0.3	1.6	1.6	1.6	1.6	1.6	1.7	1.3	0.6	0.1	-1.0	-1.3	-2.1
-3.9	-3.1	-1.8	0.0	1.6	1.6	1.6	1.6	1.4	1.6	1.6	1.6	1.6	1.6	1.6	2.8	2.2	2.2	2.2	2.2	2.2	2.0	1.8	1.8	1.6	1.6
-3.6	-4.1	-4.5	-4.8	-4.8	-5.5	-5.8	-6.3	-6.0	-5.4	-3.5	-2.3	-1.7	-0.6	-1.5	-1.8	2.2	2.2	2.2	1.2	1.5	1.3	0.1	-0.1	-0.6	-1.1
-6.5	-4.2	-4.2	-4.2	-3.8	-3.0	-3.4	-2.6	-2.0	-2.6	-3.0	-2.5	-0.5	0.0	1.2	1.4	2.1	2.3	2.3	2.0	1.8	1.1	0.5	0.0	-0.5	-1.9
																								-0.1	-0.5
-14.0	-12.0	-11.5	-11.0	-10.7	-10.7	-10.2	-10.5	-10.3	-10.0	-6.0	-3.9	-2.1	0.0	1.4	1.8	1.9	1.8	1.8	1.4	1.0	0.7	0.5	0.0	-0.5	-2.3
-7.5	-7.0	-7.5	-7.2	-7.4	-7.7	-7.7	-7.7	-7.7	-7.5	-6.8	-6.0	-3.8	-2.5	-1.8	-1.3	-0.8	-0.7	-0.4	-0.4	-0.4	-0.4	-0.7	-0.8	-1.3	-1.8
-3.5	-3.0	-2.5	-1.9	1.7	2.2	2.3	2.7	2.4	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.6	2.1	1.8	0.7	0.4	-0.2	-0.7	-1.4
-17.5	-17.5	-17.3	-17.0	-16.7	-15.7	-13.5	-12.5	-9.5	-7.0	-6.5	-5.5	-1.8	-1.0	-3.0	-2.5	-2.0	-1.5	-1.0	-0.7	-0.9	-1.0	-1.3	-1.6	-2.8	-3.1
-21.0	-21.0	-21.5	-22.0	-12.5	-23.5	-19.0	-18.0	-14.5	-11.8	-10.0	-8.5	-7.5	-6.7	-6.3	-6.0	-5.5	-4.8	-4.0	-3.5	-2.7	-2.8	-2.7	-3.0	-3.7	-4.1
-11.5	-10.0	-9.5	-9.0	-7.5	-6.6	-6.1	-5.5	-4.9	-3.7	-2.0	-0.8	0.5	2.2	2.2	2.2	2.0	2.0	2.2	2.2	2.2	2.2	2.0	1.8	2.2	2.2
-1.7	-2.0	-1.0	-0.8	-0.5	0.6	0.7	0.7	-0.3	0.3	0.8	1.7	1.7	1.7	1.7	2.2	2.3	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
-0.8	-0.7	-0.5	-0.5	0.5	-0.5	-0.4	-0.3	-0.3	-0.3	-1.0	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	-1.2	-2.0
0.0	0.0	-0.3	-0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	-0.1	-0.3	0.0	-0.2	-0.1	0.0	0.0	-0.8	-1.5
-11.4	-11.9	-11.3	-11.4	-11.3	-11.1	-10.2	-9.0	-5.7	-3.7	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-0.3	-2.5	-3.0
-1.2	-0.7	-0.5	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.7	-0.3	-0.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.5	-0.8	-0.9	-1.5
-0.6	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	0.3	-0.5	-0.7	0.0	-0.5	-1.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.5	-1.0	0.8	-1.0
-4.7	-5.0	-5.7	0.0	-6.0	-7.0	-7.1	-7.7	-5.0	-2.7	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.6	-0.1	-0.5	-0.8	-1.0	-1.7
0.0	0.0	0.0	-1.5	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.5	-0.7	-0.5
-5.5	-2.5	-1.5		0.0	0.0	-0.5	-0.5	-1.5	0.0	0.0	-0.5	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.5	-1.5	-2.3

*NOTE

(1)

ILL RESERVOIR

	JULY				AUGUST				SEPTEMBER				OCTOBER				NOVEMBER				DECEMBER			
22	1	8	15	22	1	8	15	22	1	8	15	22	1	8	15	22	1	8	15	22	1	8	15	22
0.6	0.3	-0.4	-0.6	-1.3	-1.2	-1.5	-2.5	-4.0	-4.6	-4.6	-5.5	-6.0	-6.6	-7.3	-8.0	-9.0	-9.7	-10.3	-10.8	-11.3	-12.0	-13.0	-12.6	-12.8
1.6	1.6	1.6	1.6	1.3	1.0	0.4	0.0	-0.3	-0.2	-0.8	-1.2	-1.6	-2.4	-3.3	-3.5	-3.8	-4.5	-5.0	-5.5	-6.0	-5.3	-4.4	-4.0	-3.4
0.0	0.0	-0.1	-0.3	-0.6	-1.2	-1.7	-2.1	-2.9	-3.8	-4.4	-5.1	-5.9	-6.6	-7.7	-8.7	-9.4	-10.0	-10.8	-11.7	-11.1	-11.5	-12.0	-11.2	-9.8
-1.0	-1.3	-2.1	-3.0	-3.5	-3.8	-5.1	-5.9	-6.5	-6.8	-7.4	-8.4	-9.2	-9.9	-10.9	-11.2	-12.6	-12.9	-13.6	-13.6	-13.8	-13.1	-12.0	-10.0	-8.0
1.8	1.6	1.6	1.6	1.6	1.6	1.4	0.3	0.0	-0.7	-1.3	-1.9	-2.3	-3.0	-3.7	-4.8	-5.7	-3.8	-4.1	-4.3	-4.5	-3.4	-3.7	-3.8	-3.6
-0.1	-0.6	-1.1	-1.5	-1.5	-1.7	-3.1	-3.5	-4.6	-5.5	-6.2	-7.5	-8.4	-9.0	-9.6	-10.3	-11.3	-10.4	-10.9	-10.2	-10.2	-9.5	-9.0	-8.2	-6.6
0.0	0.5	-1.9	-2.0	-2.3	-4.2	-4.2	-4.8	-5.5	-5.9	-5.3	-2.8	-2.9	-3.8											
	0.1	-0.5	-1.1	-1.6	-2.0	-2.5	-2.9	-3.5	-4.3	-5.1	-6.3	-7.1	-8.0	-8.5	-9.5	-10.5	-11.0	-12.0	-13.0	-13.3	-13.2	-13.4	-13.7	-13.8
0.0	-0.5	-2.3	-2.3	-2.5	-3.5	-3.8	-4.0	-4.6	-5.0	-5.5	-6.5	-6.9	-7.8	-6.8	-7.4	-8.2	-8.3	-8.3	-7.5	-7.1	-7.1	-7.7	-6.7	-6.9
0.8	-1.3	-1.8	-2.2	-0.8	-1.1	-1.3	-2.0	-2.8	-3.2	-4.1	-4.5	-5.3	-5.1	-6.0	-6.7	-7.0	-7.4	-7.8	-5.5	-5.8	-4.7	-3.7	-3.5	-3.5
0.2	-0.7	-1.4	-2.1	-2.8	-3.3	-4.0	-4.8	-5.1	-5.9	-6.8	-8.3	-9.2	-10.0	-11.5	-12.3	-13.0	-14.5	-15.5	-17.0	-17.2	-17.5	-17.5	-17.7	-17.7
-1.6	-2.8	-3.1	-3.8	-4.2	-4.8	-5.3	-6.4	-7.1	-7.5	-8.5	-9.1	-10.0	-10.3	-10.8	-11.1	-12.0	-13.0	-13.5	-15.0	-15.8	-17.2	-18.3	-19.5	-20.5
-3.0	-3.7	-4.1	-4.8	-5.5	-6.6	-7.1	-7.7	-8.3	-9.2	-9.8	-10.6	-11.4	-11.0	-11.5	-12.3	-13.1	-12.7	-12.5	-13.0	-13.2	-13.5	-13.2	-13.3	-13.0
1.9	2.2	2.2	2.0	1.9	1.8	1.1	0.7	0.1	0.0	-0.7	-1.3	-2.1	-3.1	-3.7	-4.1	-4.2	-4.1	-4.2	-4.9	-4.8	-4.3	-3.2	-3.0	-2.7
2.2	2.2	2.2	1.7	1.0	0.4	0.2	-0.1	-0.8	-2.0	-2.5	-2.8	-2.8	-3.3	-4.0	-4.6	-5.0	-5.5	-6.1	-5.3	-4.5	-3.8	-2.1	-1.5	-0.7
-0.8	-1.2	-2.0	-2.3	-2.5	-1.8	-1.8	-2.1	-1.5	-2.2	-2.6	-3.2	-3.7	-4.1	-4.6	-5.3	-6.0	-6.8	-6.3	-4.0	-3.2	-2.8	-2.1	-1.3	-0.5
0.0	-0.8	-1.5	-2.5	-3.0	-3.8	-4.0	-5.0	-5.8	-6.7	-7.1	-7.7	-8.1	-8.5	-9.1	-9.7	-10.5	-11.3	-11.7	-11.1	-11.1	-11.2	-11.3	-11.5	-11.6
0.3	-2.5	-3.0	-4.1	-5.1	-5.0	-5.5	-6.7	-6.0	-6.7	-6.7	-4.0	-4.0	-4.2	-4.7	-3.7	-3.8	-3.7	-3.7	-3.8	-3.8	-2.5	-1.8	-1.3	-1.3
0.2	0.1	0.1	0.0	-0.2	0.5	-0.7	-0.8	-1.1	-1.3	-2.1	-3.0	-3.5	-4.2	-4.9	-3.7	-4.0	-5.0	-4.0	-2.8	-1.0	0.0	0.0	0.0	0.0
0.7	-0.3	-0.3	-0.3	-0.7	-1.5	-1.1	-1.3	-2.1	-3.0	-3.7	-4.5	-4.7	-5.5	-6.1	-6.5	-7.5	-6.5	-7.0	-7.2	-7.6	-7.0	-3.7	-5.5	-5.3
0.8	-0.9	-1.5	-2.0	-3.0	-3.0	-3.5	-4.5	-4.8	-6.5	-4.5	-4.2	-5.0	-4.8	-5.2	-5.7	-5.7	-6.0	-5.8	-5.9	-6.0	-4.5	-3.0	-2.5	-2.0
0.0	-0.5	-1.0	0.0	0.0	-0.3	-0.7	-0.8	-1.0	-1.3	-2.2	-2.7	-3.0	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.0	0.8	-1.0	-1.5	-2.5	-2.8	-3.0	-2.3	-3.0	-3.8	-3.0	-3.7	-4.0	-4.3	-6.5	-6.0	-5.0	-4.8	-4.5	-4.5	-4.8	-5.1	-5.5	-4.0	-4.3
0.8	-1.0	-1.7	-2.1	-2.5	-3.0	-3.9	-4.5	-4.5	-5.3	-6.0	-7.0	-7.7	-7.0	-7.3	-7.0	-6.7	-6.4	-6.0	-3.0	-0.5	-0.2	-0.2	0.0	-0.7
0.5	-0.7	-0.5	-1.0	-0.9	-1.2	-2.2	-2.4	-3.0	-3.6	-3.9	-4.5	-4.5	-5.0	-5.8	-6.5	-7.8	-7.8	-8.7	-9.2	-9.5	-9.7	-9.0	-8.1	-7.8
0.5	-1.5	-2.3	-2.8	-3.8	-4.0	-4.8	-4.8	-5.0	-5.5	-5.6	-6.3	-6.7	-6.5	-6.0	-7.0	-7.0								

* NOTES:

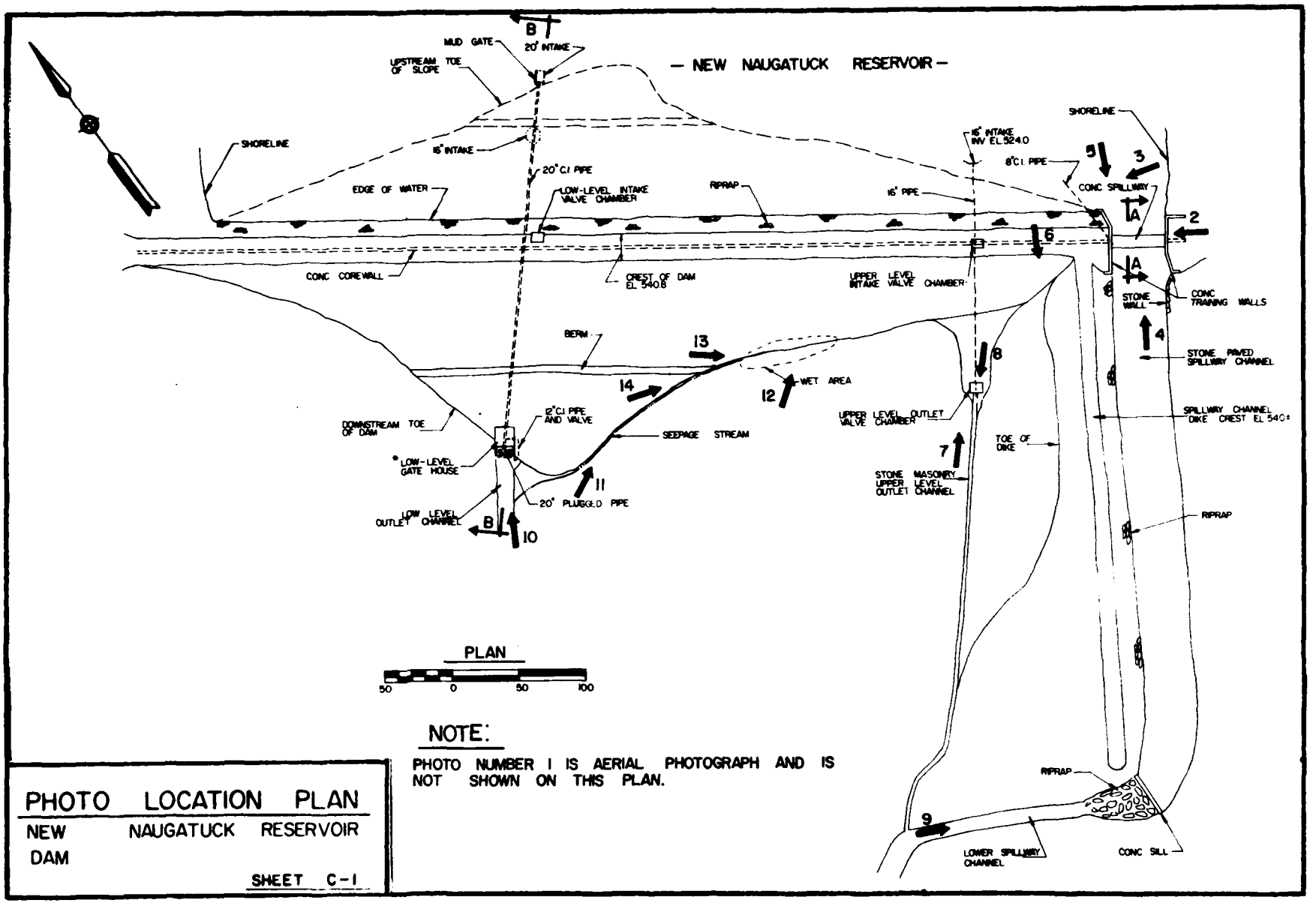
1. 27" flashboards. Removed October 1969.
2. Levels above spillway weir crest

Taken from Connecticut Water Company files. Jan. 1990

(2)

APPENDIX C

DETAIL PHOTOGRAPHS



NOTE:

PHOTO NUMBER 1 IS AERIAL PHOTOGRAPH AND IS NOT SHOWN ON THIS PLAN.

PHOTO LOCATION PLAN

NEW NAUGATUCK RESERVOIR DAM

SHEET C-1

Photo 1 - Crest and downstream slope. Low-level and upper level intake valve chambers (Nov. '79)

Photo 2 - Crest of dam (Nov. '79)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	New Naugatuck Reservoir Dam Beacon Hill Brook Bethany, Connecticut
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	CE #27 660 KE DATE Dec '79 PAGE C-1

Photo 3 - Upstream slope. Intake structure for upper level intake at right of photograph (Nov. 1979)

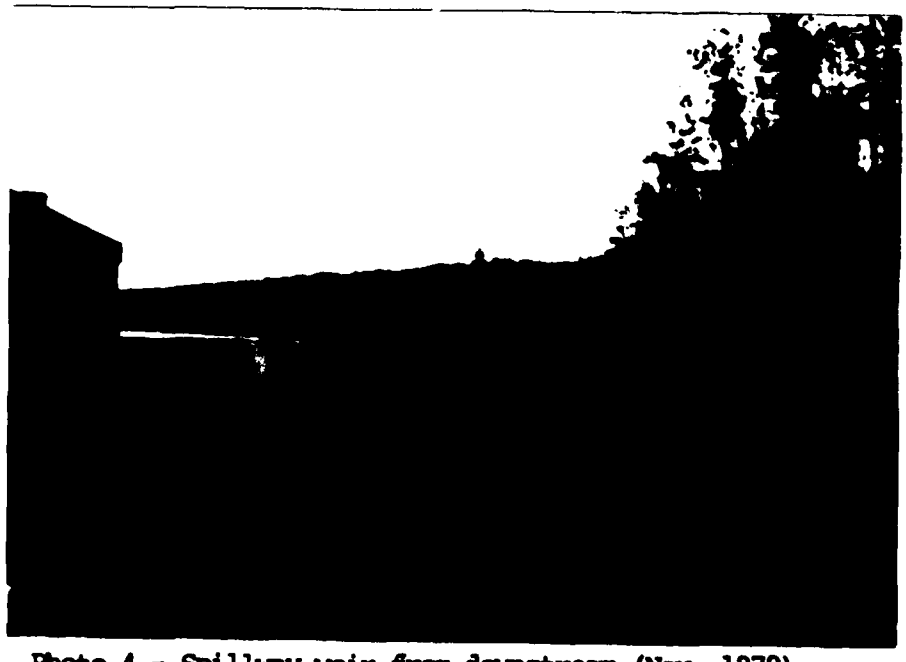


Photo 4 - Spillway weir from downstream (Nov. 1979)

Photo 5 - Spillway channel and slope of dike (Nov. 79)

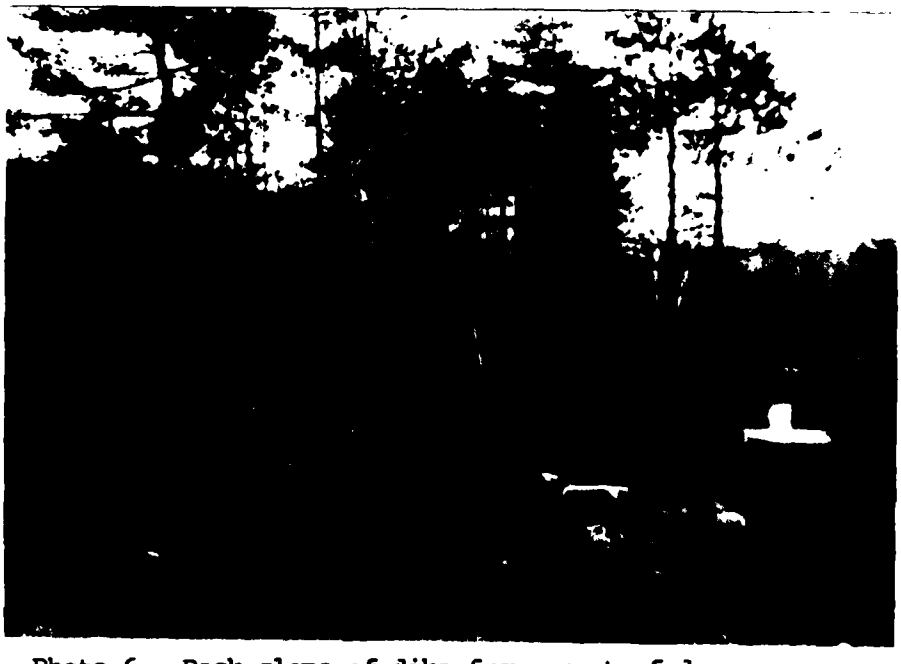


Photo 6 - Back slope of dike from crest of dam.
Chamber for upper level outlet valve at right of photo.
(Nov. 1979)

Photo 7 - Pipe and valve chamber for upper level outlet. Upper valve chamber for intake on crest behind pole.(Nov. 1979)

Photo 8 - Discharge channel for upper level outlet taken from outlet valve chamber. Lower spillway channel in background.(Nov. 1979)

Photo 9- New riprap (upper section) and mortar lined lower spillway channel (Nov. 1979).

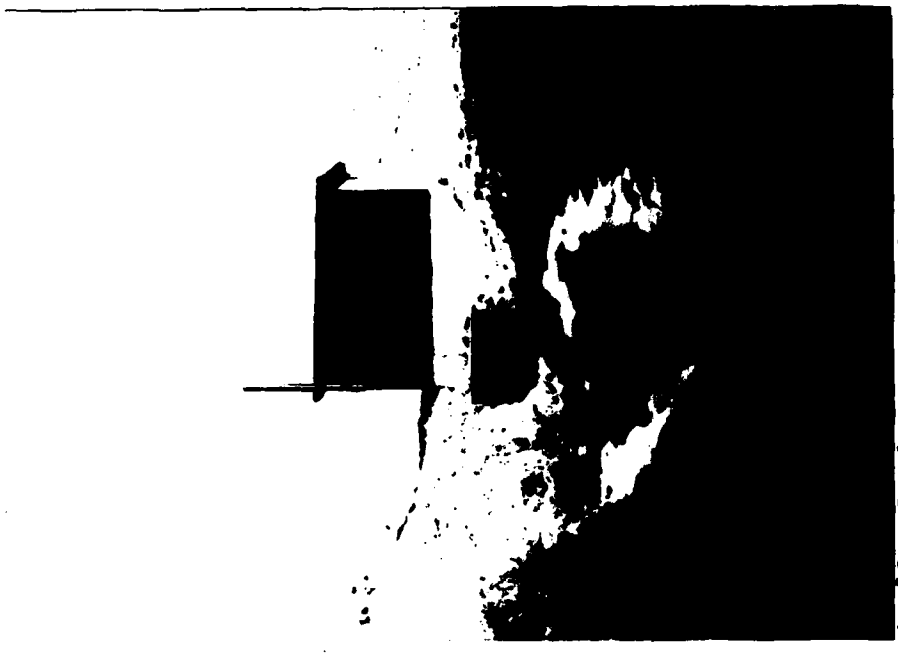


Photo 10 - Gatehouse at the downstream toe of the dam and 12 inch manually controlled outlet valve. (Jan. '80)

Photo 11- Seepage at central part of the toe of the dam, left of the gatehouse. (Nov. 1979)

Photo 12 - Seepage at left portion of the dam toe. Toe of dam is in upper left of photo. (Jan. 1980)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	New Naugatuck Res. Dam Beacon Hill Brook Bethany, Connecticut
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	CE# 27 660 KE DATE Dec '79 PAGE C-6

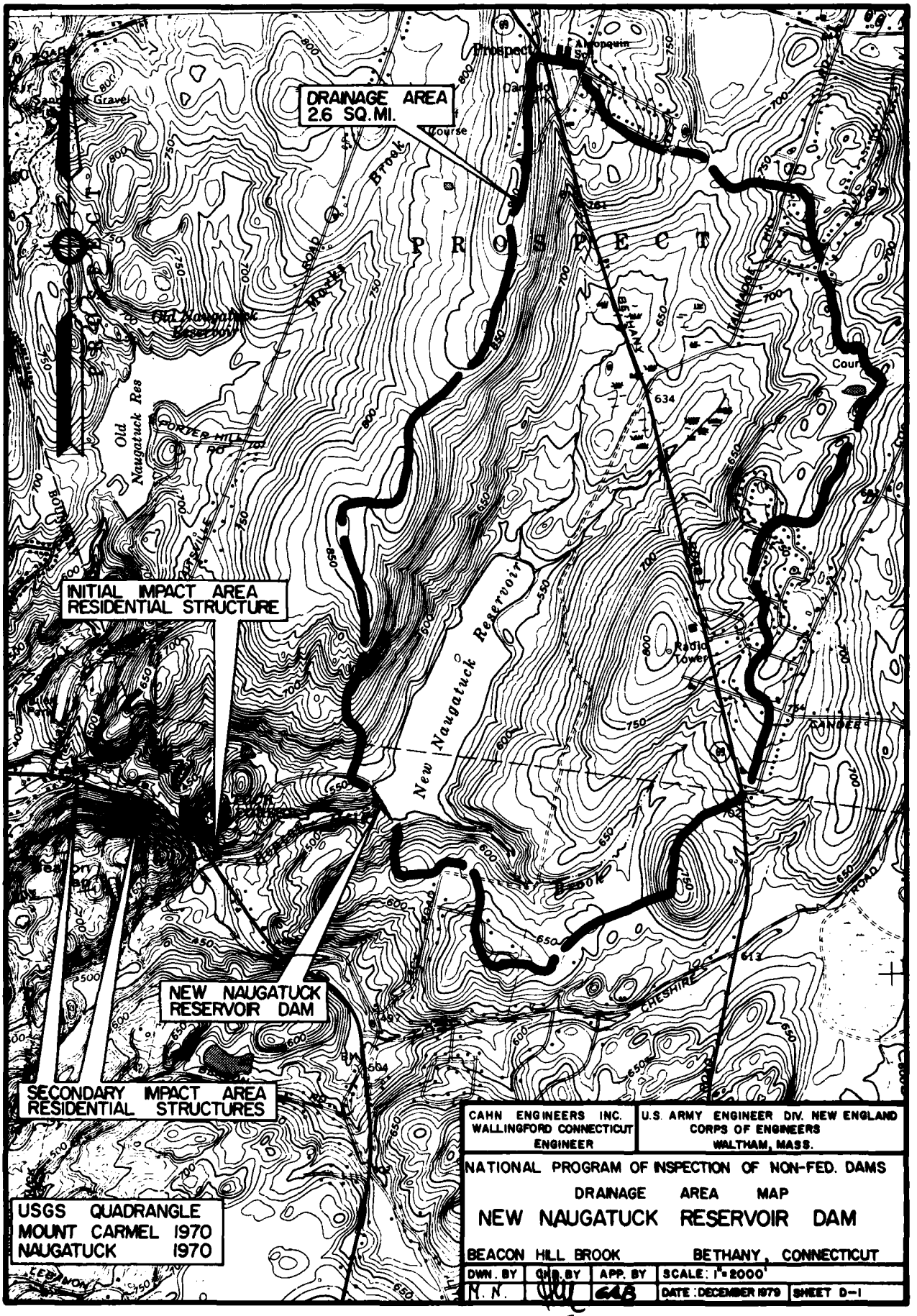
Photo 13 - Wet area with seepage flow along left portion of toe. (Jan 1980)

Photo 14 - Seepage from left portion of the toe of the dam flowing toward lower central portion of toe near gatehouse. (Jan.'80)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	New Naugatuck Res. Dam Beacon Hill Brook Bethany, Connecticut CE#27 660 KE DATE Dec '79 PAGE C-7
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER		

APPENDIX D

HYDRAULIC/HYDROLOGIC COMPUTATIONS


DRAINAGE AREA
2.6 SQ.MI.
INITIAL IMPACT AREA
RESIDENTIAL STRUCTURE
NEW NAUGATUCK
RESERVOIR DAM
SECONDARY IMPACT AREA
RESIDENTIAL STRUCTURES
USGS QUADRANGLE
MOUNT CARMEL 1970
NAUGATUCK 1970
PROSPECT
New Naugatuck Reservoir
Old Naugatuck Res
Old Naugatuck Reservoir
BEACON HILL BROOK
PORTER HILL
CHESHIRE
CAHN ENGINEERS INC.
WALLINGFORD CONNECTICUT
ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
DRAINAGE AREA MAP
NEW NAUGATUCK RESERVOIR DAM
BEACON HILL BROOK BETHANY, CONNECTICUT
DWN. BY
CHK. BY
APP. BY
SCALE: 1"=2000'
DATE: DECEMBER 1979
SHEET D-1

HYDROLOGIC / HYDRAULIC INSPECTION

NEW NAUGATUCK RESERVOIR DAM (LONG HILL DAM), BETHANY, CT.

I) PERFORMANCE AT PEAK FLOOD CONDITIONS

1) PROBABLE MAXIMUM FLOOD (PMF)

a) WATERSHED CLASSIFIED AS "ROLLING"

b) WATERSHED AREA: DA ≅ 2.55 SQ MI

NOTE: FROM CONN. DEP, BULLETIN NO. 1 1972 (GAZETTEER OF NATURAL DRAINAGE AREAS), P. 65. C.E. CHECK MEASURE DA: 2.45 SQ MI

c) PEAK FLOODS (FROM NED-ACE GUIDELINES - GUIDE CURVES FOR PMF):

i) PMF ≅ 2100 CFS/SQ MI × 2.55 ≅ 5400 CFS

ii) ½ PMF ≅ 2700 CFS

2) SURCHARGE AT PEAK INFLOWS (PMF AND ½ PMF):

a) OUTFLOW RATING CURVE

i) SPILLWAY.

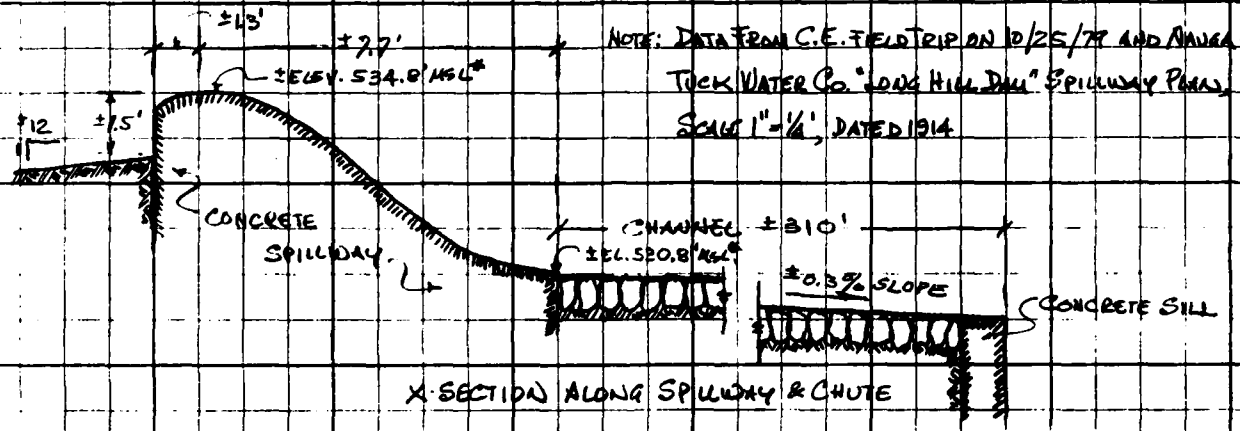
NEW NAUGATUCK RESERVOIR SPILLWAY IS A CONCRETE OGEE TYPE SPILLWAY WITH A (±) 40.5' LONG CREST AT (±) ELEV.* 534.8' MSL (SIDEWALLS SLIGHTLY BATTERED). THE HEIGHT BETWEEN THE SPILLWAY CREST AND THE TOP OF THE DAM IS H = 6'. THE APPROACH CHANNEL SLOPES AT (±) 12" TO 1' AND ITS DEPTH TO THE CREST OF THE SPILLWAY IS P ≅ 1.5' (SEE SKETCH P. D-2). THE SPILLWAY APRON IS (±) 4' LOWER THAN THE CREST AND DISCHARGES INTO A (±) 40' WIDE TRAPEZOIDAL CHANNEL (CHUTE) OF STONE PAVED INVERT WHICH EXTENDS FOR (±) 310' AT (±) 0.3% SLOPE BEFORE DROPPING OVER A CONCRETE SILL INTO A STEEP

*SEE NOTE P. D-2

NEW NAUGATUCK RESERVOIR DAM

2,e - Cont'd) - OUTFLOW RATING CURVE - SPILLWAY

IRREGULAR CHANNEL LINED WITH LARGE BOULDERS WHICH LEADS TO THE NATURAL STREAM BELOW THE DAM.



X-SECTION ALONG SPILLWAY & CHUTE

NOTE: DATA FROM C.E. FIELD TRIP ON 10/25/79 AND NAUGATUCK WATER CO. "LONG HILL DAM" SPILLWAY PLAN, SCALE 1"=1/4', DATED 1914

THE RIGHT SIDE OF THE U/S PORTION OF THE CHUTE (2"TO1" SLOPE) IS A DIKE WHICH RUNS (±) PERPENDICULAR TO THE DAM. THE TOP OF THE DIKE SLOPES DOWNWARD AT (±) 0.5% FROM (±) ELEV. 539.7' MSL AT THE DAM. THE LEFT SIDE OF THE CHUTE IS, IN GENERAL, THE NATURAL TERRAIN AND THEREFORE, VARIES IN SLOPE. HOWEVER, AT BOTH ENDS OF THE CHANNEL REACH (SPILLWAY AND DROP) THE LEFT SIDE SLOPE APPROACHES 2"TO1". THEREFORE, THE CHUTE IS ASSUMED TO HAVE 2"TO1" SIDE SLOPES.

ASSUMING NORMAL DEPTH AT THE SPILLWAY APRON (TW) AND $n = 0.025$ FOR THE CHANNEL, THE SPILLWAY WILL BE SUBMERGED AT FLOWS OVER (±) 1900 cfs ($Y_0 \geq 4'$). SPILLWAY CAPACITY WITHIN THE SUBMERGED RANGE CAN BE APPROXIMATED BY THE VILLEMONTE'S EQUATION):

$$\frac{Q_s}{Q_1} = \left[1 - \left(\frac{H_2}{H_1}\right)^{1.5}\right]^{0.385} \quad \text{or,} \quad \frac{Q_2}{Q_2} + \left(\frac{Q_s}{Q_1}\right)^{2.60} = 1$$

*NOTE: ELEVATIONS ON ADJACABLE DAMS ARE BASED ON THE TOWN OF NAUGATUCK (OLD) DATUM AND ARE CONVERTED TO MSL AS FOLLOWS (INFO. BY THE TOWN ENGINEER, 11/6/79):

MSL (USC&GS DATUM) = NAUGATUCK DATUM + 150.79' (USE +150.8')

MSL ELEVS. ARE EQUIVALENT TO NATIONAL GEODETIC VERTICAL DATUM (NGVD)

NEW MALGHAM RESERVOIR DAM

2, a - Cont'd) - OUTFLOW RATING CURVE - SPILLWAY

WHERE Q_1 AND Q_2 ARE FREE FLOW DISCHARGES UNDER THE HEADS H_1 AND H_2 (H_1 AND H_2 FROM THE SPILLWAY) AND Q_s IS THE ACTUAL FLOW FOR THE SUBMERGED CONDITION.

ASSUMING $C = 3.7$ FOR THE FREE FLOW AT THE SPILLWAY:

$$Q_1 = C L H_1^{3/2} = 150 H_1^{3/2} \qquad (C = 3.7;\ L = 40.5')$$

$H_2 = Y_n - 4$ FOR P_1 CHANNEL NORMAL DEPTH VALUES (Y_n) CORRESPONDING TO THE ACTUAL FLOW (Q_s) OVER THE SPILLWAY

THE SIMULTANEOUS SOLUTION OF THE MANNING'S (CHANNEL) AND VILLEMONTE'S (SPILLWAY) EQUATIONS GIVE THE FLOW RATING CURVE VALUES TABULATED BELOW AND PLOTTED ON P. D-5

	Y_n (FT)	H_2 (FT)	Q_s (CFS)	H_1 (FT)	
	1	—	132	0.9	NOTE (Y_n) IS NORMAL DEPTH
	2	—	425	2.0	ABOVE THE CHUTE BOTTOM (TW)
	3	—	848	3.2	AND (H_1) IS THE CORRESPONDING SURCHARGE (Y_s)
	4	0	1390	4.4	ABOVE THE SPILLWAY
	5	1	2060	5.8	CREST (EL. 534.8' MSL)
*	5.1	1.1	2130	6.0	* THE DAM WILL BE OVERTOPPED
	5.2	1.2	2210	6.2	FOR SURCHARGES $H_1 \geq 6'$
	5.5	1.5	2440	6.6	($Q_s \geq 2130$ CFS)
	5.83	1.83	2700	7.1	
	6	2	2840	7.4	
	6.2	2.2	3020	7.7	
	8.55	4.55	5400	11.7	

NEW MALTAUCK RESERVOIR DAM

2, c-Cont'd) OUTFLOW RATING CURVE

ii) EXTENSION OF THE RATING CURVE FOR SURCHARGES OVERTOPPING THE DAM

THE DAM IS AN EARTH FILL EMBANKMENT (±)20' WIDE AT THE TOP (±ELEV.* 540.8' MSL). THE TOTAL LENGTH OF THE DAM AND SIDE TERRAIN AT THIS ELEVATION IS (±)750'. THE TERRAIN TO THE RIGHT OF THE DAM RISES (±)14" TO 1' AND TO THE LEFT (±)32" TO 1'. BOTH FACES OF THE DAM (U/S AND D/S) SLOPE AT 2" TO 1'.

ASSUME $C_c = 3.0$ FOR FLOW OVER THE TOP OF THE DAM AND $C_c = 2.5$ FOR FLOW OVER THE SLOPING TERRAIN

ASSUMING ALSO EQUIVALENT LENGTHS FOR THE SLOPING TERRAIN, THE FOLLOWING FORMULAS ARE DEVELOPED TO APPROXIMATE THE OVERFLOW, USING THE SPILLWAY CREST ELEVATION AS DATUM:

1') TOP OF DAM: $L_o = 750'$ $\therefore Q_o = 2250 (H_1 - 6)^{3/2}$

2') SIDE (SLOPING) TERRAIN:

$$L'_{R,L} = \frac{2}{3}\frac{(14+32)}{11.5}(H_1 - 6) \therefore Q'_{R,L} = 29 (H_1 - 6)^{5/2}$$

THEREFORE, THE TOTAL OUTFLOW RATING CURVE IS APPROXIMATED BY:

$$Q = Q_s + Q_o + Q'_{R,L} = Q_s + 2250 (H_1 - 6)^{3/2} + 29 (H_1 - 6)^{5/2}$$

WHERE Q_s IS THE SPILLWAY OVERFLOW GIVEN ON P. D-3. THE RESULTING OUTFLOW RATING CURVE IS PLOTTED ON NEXT PAGE.

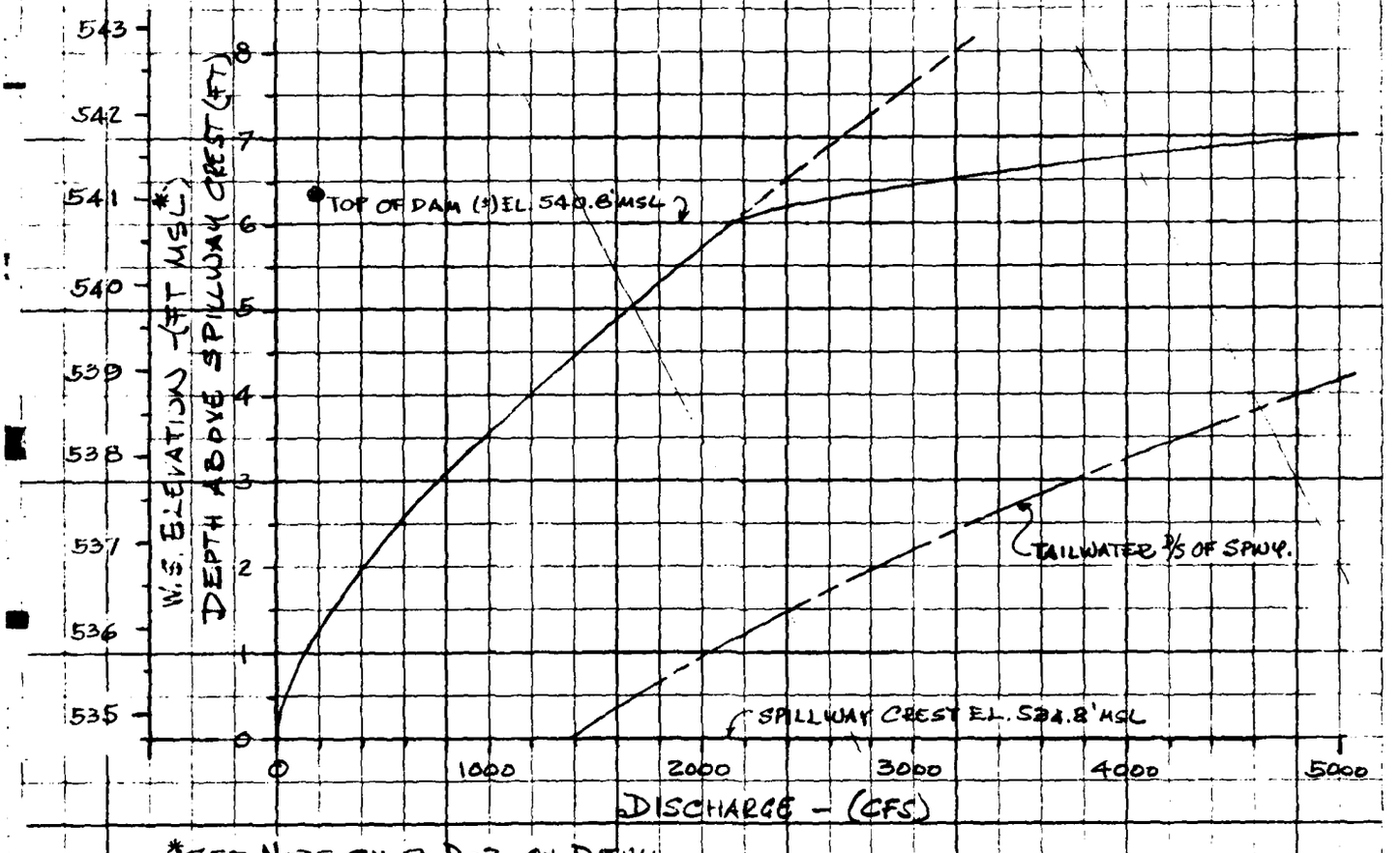
*SEE NOTE P. D-5

Cahn Engineers Inc. — Consulting Engineers

Project: NON-FEDERAL DAMS INSPECTION — Sheet D-5 of 14
Computed By: [illegible] — Checked By: GAB — Date: 11/8/79
Field Book Ref. — Other Refs.: JE #27-660-HB — Revisions

NEW NAUGATUCK RESERVOIR DAM

2.a - Cont'd) OUTFLOW RATING CURVE



*SEE NOTE ON P. D-2 ON DATUM.

b) SURCHARGE HEIGHT TO PASS PEAK INFLOWS (Q_p & Q'_p)

c) @ Q_p = PMF ≅ 5400 CFS — H_1 ≅ 7.1'

ii) @ Q'_p = ½ PMF ≅ 2700 CFS — H'_2 ≅ 6.3'

NOTE: AVAILABLE DRAWINGS OF THE NEW NAUGATUCK RESERVOIR DAM (LONG HILL) DATED 1913-14, GIVE TOP OF DAM ELEV. 391 MAUG. (E 541.8' MSL). HOWEVER C.E. FIELD TRIP OF 10/25/79 AND SURVEY OF 11/6/79 SHOW TOP OF DAM AT (±) 540.8' MSL

D-5

NEW NAUGATUCK RESERVOIR DAM

2- Cont'd) SURCHARGE AT PEAK INFLOWS (PMF & ½ PMF):

c) EFFECT OF SURCHARGE STORAGE ON PEAK OUTFLOWS:

(i) AVE. LAKE AREA WITHIN EXPECTED SURCHARGE:

1') LAKE AREA AT FLOWLINE (ELEV 534.8' MSL) (ASSUME A_{WL} TO BE APPROX THE SAME AS AT ELEV. 534' MSL*): $A_{WL} \doteq 84^{AC}$

2') AREA AT CONTOUR 540' MSL*: $A_{540} \doteq 106^{AC}$

2') AREA AT CONTOUR 550' MSL*: $A_{550} \doteq 133^{AC}$

∴ AREA AT ELEV 542' MSL (MAX. EXPECTED SURCH.) $A_{542} \doteq 111^{AC}$

∴ AVE AREA WITHIN EXPECTED SURCHARGE: $\bar{A} \doteq \underline{98}^{AC}$

*NOTE: AREAS FROM USGS MOUNT CARMEL QUADRANGLE SHEET

(ii) ASSUME NORMAL POOL AT FLOWLINE ELEVATION: ELEV 534.8' MSL

(iii) WATERSHED AREA: D.A. = 2.55 $^{SQ\,MI}$ (SEE P. D-1)

(iv) DISCHARGE ($Q_{1/2}$) AT VARIOUS HYPOTHETICAL SURCHARGE ELEVATIONS:

$H = 8'$ $V = 98 \times 8 = 784^{AC\text{-}FT}$ $\therefore S = \frac{784}{2.55 \times 53.3} = 5.77''$

$H = 4'$ $V = 392^{AC\text{-}FT}$ $\therefore S = 2.88''$

FROM APPROXIMATE ROUTING NED-ACE GUIDELINES AND 19" MAX. PROBABLE R.O. IN NEW ENGLAND:

$Q_{1/2} = Q_{1/1}\left(1 - \frac{S}{19}\right)$ AND FOR ½ PMF: $Q_{1/2}' = Q_{1/1}'\left(1 - \frac{S}{9.5}\right)$

NEW MANCHAUG RESERVOIR DAM

2, c-(cont'd) EFFECT OF SURCHARGE STORAGE ON PEAK OUTFLOWS:

FOR THE PREVIOUS HYPOTHETICAL SURCHARGES

$H = 8'$ $Q_{p_2} = 3760^{cfs}$ $Q'_{p_2} = 1060^{cfs}$

$H = 4'$ $Q_{p_2} = 4580^{cfs}$ $Q'_{p_2} = 1880^{cfs}$

AND FOR $H = 0'$ $Q_{p_2} = 5400^{cfs}$ $Q'_{p_2} = 2700^{cfs}$

d) PEAK OUTFLOWS (Q_{p_3} & Q'_{p_3})

(USING NED-ACE GUIDELINES "SURCHARGE STORAGE ROUTING" ALTERNATE METHOD (SEE RATING CURVE P. D-5):

$Q_{p_3} \doteq 4150^{cfs}$ $H_3 \doteq 6.8'$ FOR $Q_{p_1} = PMF$

$Q'_{p_3} \doteq 1680^{cfs}$ $H'_3 \doteq 5.0'$ FOR $Q'_{p_1} = \frac{1}{2} PMF$

3) SPILLWAY CAPACITY RATIO TO PEAK INFLOWS AND OUTFLOWS:

a) SPILLWAY CAPACITY TO TOP OF DAM ($H = 6'$): $Q_s \doteq 2130^{cfs}$

∴ THE SPILLWAY CAPACITY IS (±) 39% OF THE INFLOW (Q_{p_1}) AND (±) 51% OF THE OUTFLOW (Q_{p_3}) AT PEAK FLOOD = PMF.
LIKEWISE, THE SPILLWAY CAPACITY IS (±) 79% OF THE INFLOW (Q'_{p_1}) AND (±) 127% OF THE OUTFLOW (Q'_{p_3}) AT PEAK FLOOD = ½ PMF.

b) SPILLWAY CAPACITY TO PMF AND ½ PMF SURCHARGES:

i) CAPACITY TO PMF SURCHARGE ($H_3 \doteq 6.8'$): $Q_s \doteq 2520^{cfs}$

NEW MILFORD RESERVOIR DAM

3.6 - Cont'd) SPILLWAY CAPACITY RATIO TO PMF AND ½ PMF SURCHARGES

∴ THE SPILLWAY CAPACITY TO PMF SURCHARGE IS (±) 47% OF THE INFLOW (Q_p) AND (±) 61% THE OUTFLOW (Q_p) AT PEAK FLOOD = PMF

ii) CAPACITY TO ½ PMF SURCHARGE ($H_3' \cong 5'$): $(Q_s'')' = Q_{1/3}' \cong 1650^{cfs}$

BECAUSE THE ESTIMATED SURCHARGE TO PASS ½ PMF DOES NOT OVERTOP THE DAM ($H_3' < 6'$), THESE CAPACITY RATIOS ARE NOT ESTIMATED.

NOTE: NEW MILFORD RESERVOIR DAM HAS 2 - VALVED PIPE OUTLETS WHICH ARE USED MAINLY TO MAINTAIN (AUTOMATICALLY) THE DESIRED LEVEL AT A W/S DISTRIBUTION RESERVOIR (TWITCHELL RESERVOIR) FOR WATER SUPPLY PURPOSES. - THE TWO OUTLETS - (16"Ø AND 20"/16"Ø) TAP NEW MILFORD RESERVOIR AT DIFFERENT LEVELS. - THE 16"Ø, (±) 100' LONG HAS THE OUTLET AT (±) ELEV. 520.3' MSL (INLET (±) EL. 524' MSL) AND ITS MAX. CAPACITY (NEGLECTING VALVE LOSSES) IS ESTIMATED AT (±) 25 cfs (W.L. AT TOP OF DAM). THE 20"/16"Ø OUTLET IS MAINLY A 20"Ø PIPE (±) 290' LONG WITH OUTLET AT (±) ELEV. 460' MSL NEAR THE TOE OF THE DAM, AND TWO INLETS; ONE 16"Ø AT ELEV. (±) 504.8' MSL IN A VERTICAL RISER AT THE U/S FACE OF THE DAM AND THE OTHER, A 20"Ø INLET AT ELEV. (±) 485.5' MSL (± BOTTOM OF THE RESERVOIR). THE OUTLET OF THIS 20"/16"Ø PIPE, HAS BEEN CAPPED, HOWEVER, AND BRANCHED WITH A 12"Ø PIPE FOR THE INSTALLATION OF ONE AUTOMATIC (TWITCHELL RES. LEVEL) CONTROL VALVE. ASSUMING THE 20"Ø PIPE, WITHOUT EITHER THE AUXILIARY 16"Ø INLET OR THE 12" VALVED OUTLET, THE MAX. CAPACITY OF THE CONDUIT OUTLET IS ESTIMATED AT (±) 15 cfs (W.L. AT TOP OF DAM). (DATA FROM C.E. FIELD NOTES OF 10/25/79 AND CONNECTICUT WATER CO. "OPERATIONS & MAINTENANCE MANUAL, LAKE MILFORD RESERVOIR" DATED 10/25/79)

NEW NAUGATUCK RESERVOIR DAM.

II) DOWNSTREAM FAILURE HAZARD

1) POTENTIAL IMPACT AREA

SEVERAL HOUSES ALONG BEACON HILL BROOK, PARTICULARLY THOSE LOCATED (±) 3000' TO 7000' ± FROM THE DAM ON ROUTE 63, HAVING FIRST FLOOR ELEVATIONS FROM (±) 5' TO 13' ABOVE THE STREAM CONSTITUTE THE POTENTIAL IMPACT AREA IN CASE OF FAILURE OF THE NEW NAUGATUCK RESERVOIR DAM.

2) FAILURE AT NEW NAUGATUCK RESERVOIR DAM.

a) BREACH WIDTH:

i) HEIGHT OF DAM:

TOP OF DAM (±) ELEV. 540.8' MSL

D/S TOE OF DAM (STREAMBED) - (±) ELEV. *461' MSL

$\therefore H = 80'$

ii) MID-HEIGHT OF DAM. (±) ELEV. 501' MSL ($540.8 - \frac{80}{2} = 500.8$' SAY 501' MSL)

iii) APPROX. MID-HEIGHT LENGTH: $L = *210'$ (*FROM C.E. FIELD MEASUREMENTS ON 10/25/79)

iv) BREACH WIDTH (SEE NED-ACE DAM FAILURE GUIDELINES)

$W = 0.4 \times 210 = 84'$ ∴ ASSUME $W_b = 84'$

b) PEAK FAILURE OUTFLOW (Q_p)

ASSUME SURCHARGE TO TOP OF DAM (ELEV. 540.8' MSL)

c) HEIGHT AT TIME OF FAILURE: $H_w = 80'$

NEW MILLSTONE RESERVOIR DAM

2.6-(Cont'd) PEAK FAILURE OUTFLOW

(ii) SPILLWAY DISCHARGE AT TIME OF FAILURE: $Q_s \approx 2130^{cfs}$ (SEE P.D-7)

(iii) BREACH OUTFLOW (Q_b):

$$Q_b = \frac{8}{27} W_b \sqrt{g} y_o^{3/2} \approx \underline{101000}^{CFS}$$

(iv) PEAK FAILURE OUTFLOW (Q_p) TO BEACON HILL BROOK:

$$Q_p \approx Q_s + Q_b \approx \underline{103000}^{CFS}$$

c) FLOOD DEPTH IMMEDIATELY D/S FROM DAM:

$$y \approx 0.44 y_o \approx \underline{35'}$$

d) ESTIMATE OF D/S DAM FAILURE CONDITIONS AT POTENTIAL IMPACT AREA.

(SEE NED-ACE GUIDELINES FOR ESTIMATING D/S DAM FAILURE HYDROGRAPHS)

i) REACH OF BEACON HILL BROOK BETWEEN THE DAM AND THE IMPACT AREA:

THE (±)3000' LONG REACH OF BEACON HILL BROOK FROM THE NEW MILLSTONE RESERVOIR TO THE INITIAL IMPACT AREA AT RTE 63, IS APPROX. V-SHAPED WITH (±)3H TO 1V AND (±)8H TO 1V SIDE SLOPES TO A DEPTH OF (±)50'. THE AVERAGE SLOPE OF THE REACH IS (±)2.1%

ii) NEW MILLSTONE RESERVOIR STORAGE AT TIME OF FAILURE:

CAPACITY OF THE RESERVOIR TO TOP OF DAM LINE IS (±)506 MG = 1550 AC-FT. (DATA GIVEN ON 10/25/79 BY THE CONNECTICUT WATER CO.) THEREFORE,

NEW NAUGATUCK RESERVOIR DAM

2.d - Cont'd) FAILURE CONDITIONS AT IMPACT AREA

THE STORAGE AT TIME OF FAILURE IS APPROXIMATELY:

$S_{MAX} = 1550 + 6 \times 98 = \underline{2140}^{AC-FT}$ ($S_{av} = 1070^{AC-FT}$)

NOTE: THE ACE - U.S. INVENTORY OF DAMS, DATED JAN. 24, 1979, p. 31, GIVES $S_{MAX} = 2550^{AC-FT}$ AND $S_{NORM} = 2250^{AC-FT}$.

iii) PEAK INFLOW TO REACH: $Q_{P_1} = 103000^{CFS}$ (See p. D-10)

iv) APPROXIMATE STAGE AT POTENTIAL IMPACT AREA AFTER FAILURE OF NEW NAUGATUCK RESERVOIR DAM:

$Q_{P_1} = 103000^{CFS}$ ∴ $Y_1 = 27.6'$; $V_1 = 290^{AC-FT}$ ∠ $S_{av} = 2$ (on REACH OF 3000'; $n = 0.050$)

$Q_{P_2} = Q_{P_1}(1 - \frac{V}{S})_{av} = 89100^{CFS}$ ∴ $Y_{2av} = 26.2'$; $V_{2av} = 260^{AC-FT}$; $\bar{V}_{av} = 275^{AC-FT}$ ∴ $Q_{P_2} = 89800^{CFS}$

∴ REACH OUTFLOW: $Q_{P_2} = \underline{89800}^{CFS}$ STAGE: $Y_2 = \underline{26.2'}$

e) APPROXIMATE STAGE BEFORE FAILURE:

BEACON HILL BROOK FLOW BEFORE FAILURE: $Q_o = \underline{2130}^{CFS}$ ∴ $Y_o = \underline{6.5'}$

f) RAISE IN STAGE AT IMPACT AREA: $\Delta Y = 19.7'$ SAY, $\underline{20'}$

NEW NAUGATUCK RESERVOIR DAM

III) SELECTION OF TEST FLOOD

1) CLASSIFICATION OF DAM ACCORDING TO NED-ACE GUIDELINES:

a) SIZE: *STORAGE (MAX) ≈ 2140 ACFT (1000 < S < 50000 ACFT)
*HEIGHT ≈ 80' (40 < H < 100 FT)

*NOTE: STORAGE (See p. D-11); HEIGHT (SEE P. D-9)

∴ SIZE CLASSIFICATION: INTERMEDIATE

b) HAZARD POTENTIAL: AS A RESULT OF THE DS FAILURE ANALYSIS AND IN VIEW OF THE IMPACT THAT FAILURE OF NEW NAUGATUCK RESERVOIR DAM MAY HAVE ON THE POTENTIAL IMPACT AREA DESCRIBED ON P. D-9, THIS DAM IS CLASSIFIED AS HAVING:

HAZARD CLASSIFICATION: HIGH

2) TEST FLOOD: PMF ≈ 5400 CFS

THIS SELECTION IS MADE BASED ON THE RESULTS OF THE PREVIOUS ANALYSIS AND CLASSIFICATION.

NEW NAUGATUCK RESERVOIR DAM

IV) SUMMARY AND CONCLUSIONS

1) TEST FLOOD = PMF ≐ 5400 CFS
(PARALLEL COMPUTATIONS HAVE BEEN MADE FOR ½ PMF ≐ 2700 CFS AND ARE ALSO SUMMARIZED BELOW)

2) PERFORMANCE AT PEAK FLOOD CONDITIONS:

a) PEAK INFLOWS: Q_{P_1} = PMF ≐ 5400 CFS Q'_{P_1} = ½ PMF ≐ 2700 CFS

b) PEAK OUTFLOWS: Q_{P_2} ≐ 4150 CFS Q'_{P_2} ≐ 1680 CFS

c) SPILLWAY CAPACITY:

i) TO TOP OF DAM (H=6'): Q_S ≐ 2130 CFS OR, (±) 51% OF Q_{P_2} AND (±) 127% OF Q'_{P_2}

ii) TO TEST FLOOD (PMF) SURCHARGE (H_2 ≐ 6.8'): Q''_S ≐ 2520 CFS OR, (±) 61% OF Q_{P_2}

iii) TO ½ PMF SURCHARGE (H'_2 ≐ 5'): $(Q'''_S) = Q'_{P_2}$ ≐ 1680 CFS

THEREFORE, AT TEST FLOOD Q_P = PMF, THE DAM IS OVERTOPPED TO A DEPTH OF (±) 0.8' (W.S. ELEV. 541.6' MSL) OR TO A SURCHARGE OF (±) 6.8' ABOVE THE SPILLWAY CREST ELEVATION 534.8 MSL.

SIMILARLY, AT Q'_P = ½ PMF, THE SPILLWAY PASSES THE FULL OUTFLOW WITH A FREEBOARD TO TOP OF DAM OF (±) 1' (W.S. ELEV. 539.8' MSL) AND A CORRESPONDING SURCHARGE ABOVE THE SPILLWAY CREST OF (±) 5'.

UNDER BOTH FLOW CONDITIONS THE TAILWATER AT THE CHUTE WILL SUBMERGE THE SPILLWAY, BUT IT IS NOT EXPECTED TO OVERTOP THE EMBANKMENT THAT MAKES THE CHUTE'S RIGHT SIDE.

NEW NAUGATUCK RESERVOIR DAM

IV-Cont'd) SUMMARY AND CONCLUSIONS

3) DOWNSTREAM FAILURE CONDITIONS

a) PEAK FAILURE OUTFLOW: $Q_{p_f} = 103000$ CFS

b) FLOOD DEPTH IMMEDIATELY D/S FROM DAM: $Y_o \cong 35'$

c) CONDITIONS AT THE INITIAL IMPACT AREA D/S FROM DAM (BEACON HILL BRIDGE)

i) APPROXIMATE STAGE BEFORE FAILURE: $Y_i \cong 6.5'$ ($Q_s = 2130$ CFS)

ii) APPROXIMATE STAGE AFTER FAILURE: $Y_f \cong 26.2'$ ($Q_s \cong 89800$ CFS)

iii) APPROXIMATE RAISE IN STAGE AFTER FAILURE: $\Delta Y \cong 20'$

NOTE: A STORAGE VS. DEPTH TABULATION FURNISHED BY THE CONNECTICUT WATER CO. ALONG WITH OTHER DATA ENTITLED "OPERATIONS & MAINTENANCE MANUAL, LONG HILL RESERVOIR" DATED 10/25/79, INCLUDES STORAGE VALUES TO A SURCHARGE DEPTH OF 2'3" ABOVE THE CREST OF THE SPILLWAY AND DESIGNATES IT AS "TOP OF FLASHBOARDS." NO PROVISIONS FOR THE INSTALLATION OF FLASHBOARDS ARE EXISTING, HOWEVER, AND THE CONN. WATER CO. REPORTS THAT FLASHBOARDS HAVE NEVER BEEN PLACED AT NEW NAUGATUCK RESERVOIR. THEREFORE, NO ANALYSIS OF THIS DAM FOR OPERATION WITH FLASHBOARDS IS MADE.

PRELIMINARY GUIDANCE

FOR ESTIMATING

MAXIMUM PROBABLE DISCHARGES

IN

PHASE I DAM SAFETY

INVESTIGATIONS

New England Division
Corps of Engineers

March 1978

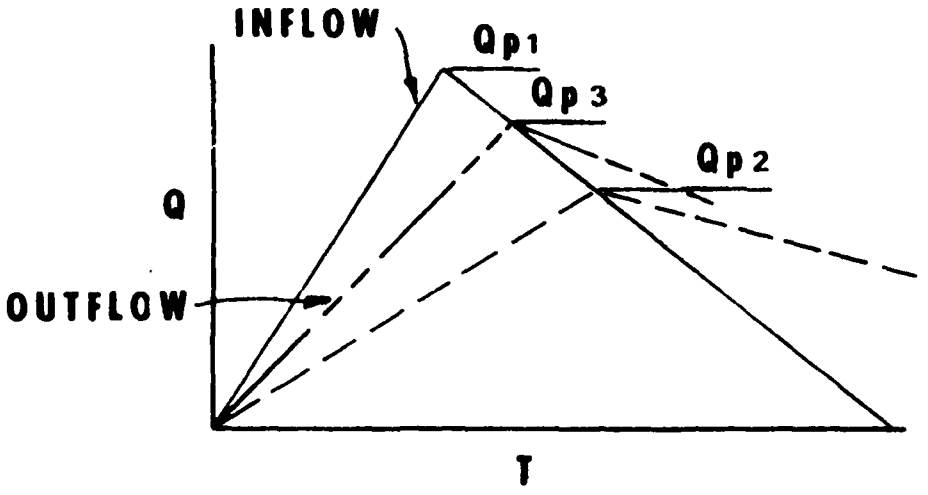
MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

	Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1.	Hall Meadow Brook	26,600	17.2	1,546
2.	East Branch	15,500	9.25	1,675
3.	Thomaston	158,000	97.2	1,625
4.	Northfield Brook	9,000	5.7	1,580
5.	Black Rock	35,000	20.4	1,715
6.	Hancock Brook	20,700	12.0	1,725
7.	Hop Brook	26,400	16.4	1,610
8.	Tully	47,000	50.0	940
9.	Barre Falls	61,000	55.0	1,109
10.	Conant Brook	11,900	7.8	1,525
11.	Knightville	160,000	162.0	987
12.	Littleville	98,000	52.3	1,870
13.	Colebrook River	165,000	118.0	1,400
14.	Mad River	30,000	18.2	1,650
15.	Sucker Brook	6,500	3.43	1,895
16.	Union Village	110,000	126.0	873
17.	North Hartland	199,000	220.0	904
18.	North Springfield	157,000	158.0	994
19.	Ball Mountain	190,000	172.0	1,105
20.	Townshend	228,000	106.0(278 total)	820
21.	Surry Mountain	63,000	100.0	630
22.	Otter Brook	45,000	47.0	957
23.	Birch Hill	88,500	175.0	505
24.	East Brimfield	73,900	67.5	1,095
25.	Westville	38,400	99.5(32 net)	1,200
26.	West Thompson	85,000	173.5(74 net)	1,150
27.	Hodges Village	35,600	31.1	1,145
28.	Buffumville	36,500	26.5	1,377
29.	Mansfield Hollow	125,000	159.0	786
30.	West Hill	26,000	28.0	928
31.	Franklin Falls	210,000	1000.0	210
32.	Blackwater	66,500	128.0	520
33.	Hopkinton	135,000	426.0	316
34.	Everett	68,000	64.0	1,062
35.	MacDowell	36,300	44.0	825

MAXIMUM PROBABLE FLOWS BASED ON TWICE THE STANDARD PROJECT FLOOD (Flat and Coastal Areas)

River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1. Pawtuxet River	19,000	200	190
2. Mill River (R.I.)	8,500	34	500
3. Peters River (R.I.)	3,200	13	490
4. Kettle Brook	8,000	30	530
5. Sudbury River.	11,700	86	270
6. Indian Brook (Hopk.)	1,000	5.9	340
7. Charles River.	6,000	184	65
8. Blackstone River.	43,000	416	200
9. Quinebaug River	55,000	331	330

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

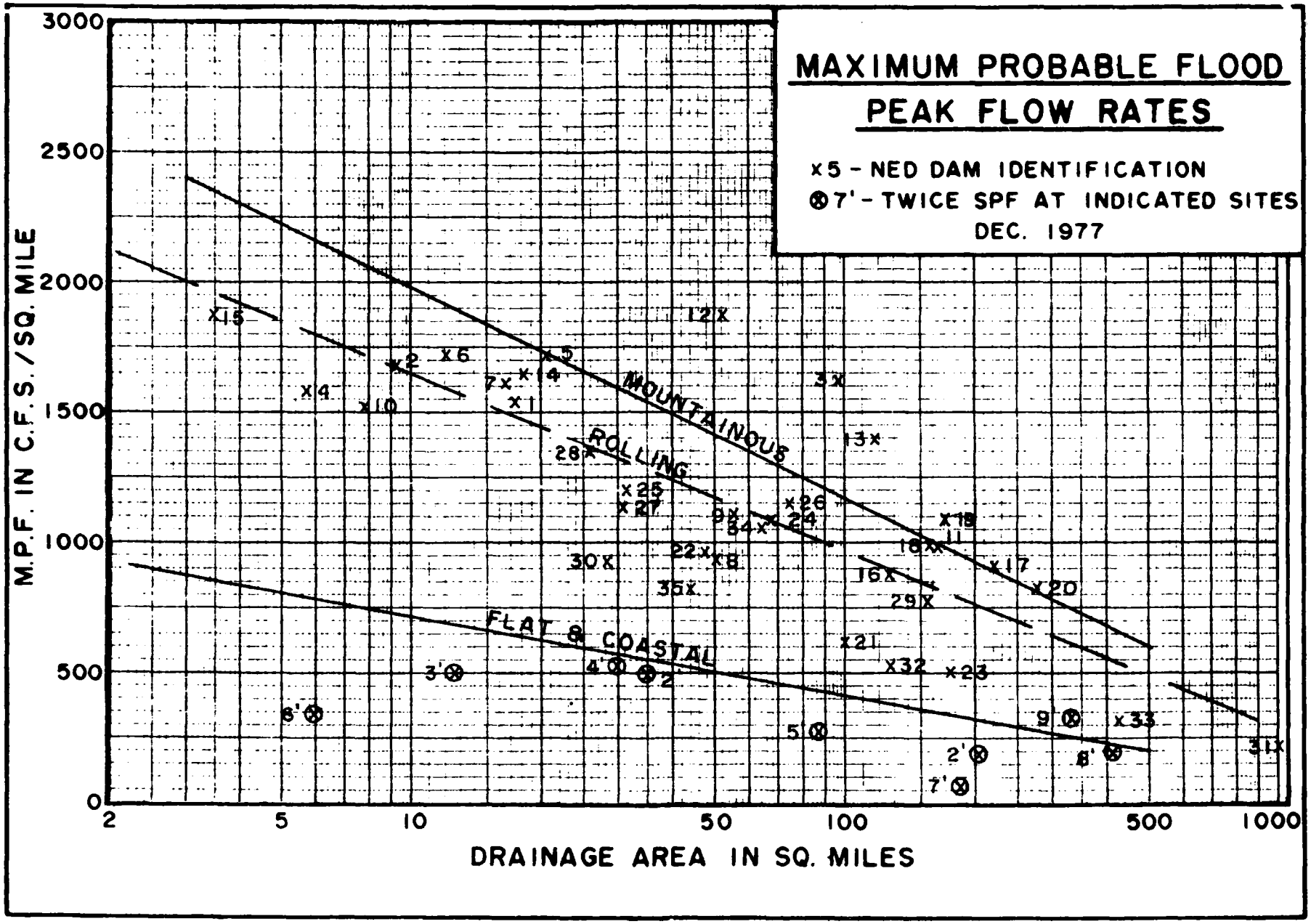
b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore:

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".


MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SITES
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
1000
MOUNTAINOUS
ROLLING
FLAT & COASTAL
x15
x4
x10
x2
x6
x14
x1
x5
12x
3x
13x
28x
x25
x27
x26
9x
x24
x18
11
16x
x17
x20
30x
22x
x8
35x
16x
29x
x21
x32
x23
3'⊗
4'⊗
2
8'⊗
5⊗
9⊗
x33
2'⊗
8'⊗
7'⊗
31x

SURCHARGE STORAGE ROUTING SUPPLEMENT

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

STEP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

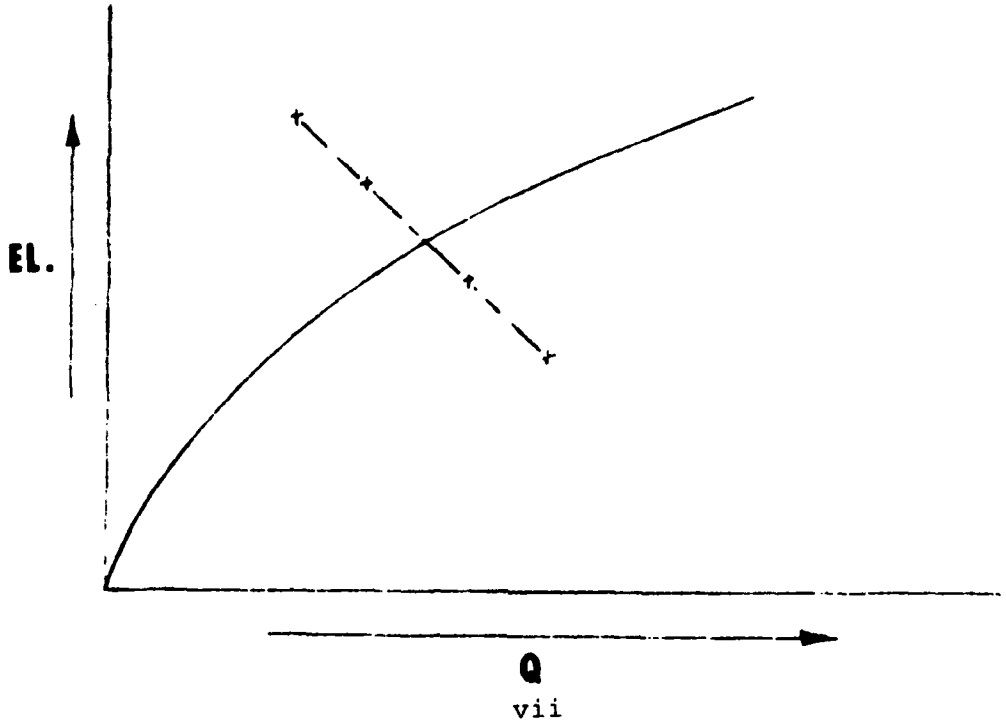
SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR}{19}\right)$$

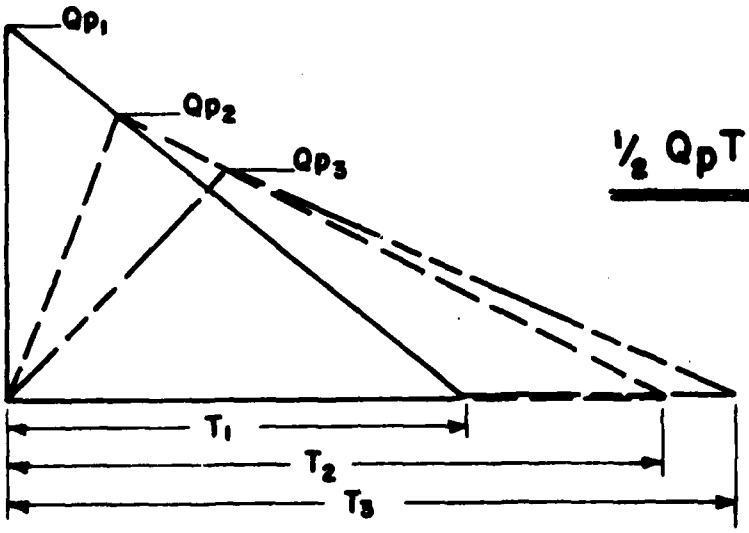
$$Q_{p2} = Q_{p1} - Q_{p1}\left(\frac{STOR}{19}\right)$$

FOR KNOWN Q_{p1} AND 19'' R.O.

Q_{p2}	STOR	EL.



"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Q_{p_1} = \frac{8}{27} W_b \sqrt{g} Y_o^{\frac{3}{2}}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Q_{p_2}(\text{TRIAL}) = Q_{p_1}\left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Q_{p_2} = Q_{p_1}\left(1 - \frac{V_{avg}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

END

FILMED

DTIC